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## THE SOUTHWESTERN NATURALIST


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# THE SPECIES AS A DYNAMIC SYSTEM[1]

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ABSTRACT. The species is a dynamic system. Understanding of the species must include understanding of the hereditary variability and of the whole interrelations of the system with its environment. Conventional systematics, with the primary aim of classification, deals with this system only in a casual and fragmentary way. There is urgent need, therefore, for studies of species as living systems, taking into account all of their attributes.

The species is the common denominator of the field naturalist. The taxonomist is concerned with the classification of species, the ecologist with what the species does in its environment. Yet, in this age of the laboratory experimentalists the tendency is to work on smaller and smaller fragments of organisms in an effort to reduce all biological phenomena to primary physical causes. These people work with fragments of protoplasm, and they look with condescension on those who are so crude as to work with whole organisms. It is desirable, therefore, to examine the attributes of species — to ask the question, are species such simple things that those who work with them are nothing but the handmaidens of their profound laboratory brethren? Or, are species complex systems, crudely known at present, and challenging the highest type of scientific effort for a solution of their problems?

Let us ask ourselves, what is a species? What are its attributes? No simple definition, however glib or however cautiously phrased, will tell us what a species is. The attributes of the species can be stated only in a general and tentative sort of way, for we know too little about any species of organism to state all of its properties. For relative simplicity we had best restrict our discussion to sexually reproducing organisms.

## GENERAL ATTRIBUTES OF SPECIES

A species exists. It has reality in time and space. It is theoretically possible to map the exact distribution of a species in space, but inadequacies in the fossil record would obviously prevent a similarly precise mapping in time.

A species is made up of individuals of which the numbers fluctuate in characteristic pattern around some mode determined by the inherent characters of the species and by the environment. At a given moment in time it is approximately correct to refer to the species as

[1] Condensed from presidential address given at second annual meeting of Southwestern Association of Naturalists, Fayetteville, Arkansas, April 29, 1955.

a population. A more precise reference would be to the total hereditary variability in the germ plasm of the population. The so-called hidden variability is as much an attribute of the species as a dynamic system in time and space as are the phenotypically expressed characteristics at a given moment in time. Hereditary traits carried in low frequency in the population could mean the difference between success and failure of the species to adapt to changing conditions.

The species exists with other more or less distantly related organisms. It utilizes some of them to meet its own requirements for existence. It competes with some of them for the necessities of existence, or avoids or minimizes competition by various means. The hereditary variability of the species is influenced and channeled by these requirements and competitive relations through selection.

The species has evolved a system of mechanisms whereby its all-important adaptive and potentially adaptive hereditary variability is protected against dilution from other related, interfertile species, through cross-breeding. These isolation mechanisms may be 100% effective, making the species a completely independent genetic system, or they may be such that they permit some introgression of traits from related, interfertile species. Continued existence of the species as an independent system is plainly dependent on maintenance of its isolation mechanism complex.

The species, then, is a dynamic system, which exists normally in equilibrium with its environment, or more precisely with its environments, for environments are uniform neither in time nor in space. The hereditary store is variable, therefore, in both time and space, as selection drives the local gene pool to locally adaptive peaks and as the dynamic system is affected by such influences as mutation, small population effects and isolation by distance.

In summation, the species is made up of a group of individuals belonging to an essentially common breeding system; these individuals are possessed of both expressed and hidden morphological, physiological and behavioral characteristics; these characteristics fall within limits of variation imposed by the past history and present adaptational pressures on the system.

## Information About Species

What do we really know about any species as a dynamic system? Most of our information comes from classical taxonomy, and it is revealing to consider what this discipline has contributed to the knowledge of the species as a dynamic system. Osgood's monograph of the genus *Peromyscus,* published in 1909, was, and still is, regarded as a classic among conventional taxonomic works. Osgood had available

27,000 specimens of 38 species. By way of perspective, Dice has estimated the population of one species (*P. maniculatus*) in the Black Hills at 2,500,000. This was an area of low density, and the total population of this species alone certainly involves many millions, possibly billions, of individuals. Osgood's knowledge of the 38 species depended on specimens representing about one per cent of the number of one species in one small part of its range. In addition, the distribution of the specimens was biased by the distribution of active study centers. Even assuming an adequate sample, what do Osgood's 27,000 specimens show? They show a few of the obvious morphological characters of some fragments of each animal. The traditional museum "skin and skull" are nothing more than the husk and a part of the core. They do not even show all of the characters of the skeleton, and they show nothing about the soft parts. They show nothing of the physiology, psychology, hidden variability and other attributes of the species as a dynamic system.

The deer mouse (*Peromyscus maniculatus*) is probably more thoroughly known in respect to its attributes as a dynamic system than any other mammal, possibly any other vertebrate. What do we know of its attributes?

In a general way we know its spatial limits of distribution. We do not know the exact limits, nor do we know, except for a few places, whether the peripheral populations are geographically static, expanding or retreating. The details of distribution within the geographic range are known only in that the species is known to prefer certain major environmental types and to avoid others in different parts of its range. The distribution of the species in time is incompletely known; the present distribution is complex with secondary contacts of subpopulations in some places. The present distribution is indicative of major distributional changes in the Pleistocene. Speciation of peripheral populations such as *polionotus* in Florida has occurred.

The numbers of individuals can only be guessed at. Population densities have been estimated in a few localities by live-trap or nest-box methods. The sizes of subpopulations, either of major ecotypes or of "neighborhoods" of Sewall Wright, are unknown.

The hereditary variability is slightly known. Buff-gray alleles are adaptively important in desert populations. A dominant buff is similarly important in the Nebraska Sand Hills. A dominant gene and numerous ones with additive effects affecting distribution of pigmented pelage is similarly important in the related species *polionotus*. Various deleterious recessives have been bred out in laboratory stocks.

The relations and the degree of competition with other species in nature are only crudely known. This is one of Elton's "key industry" species in terms of predation. Productivity is high; life span is short; few individuals reach old age.

The work of Dice and others has shown incrossability with other *Peromyscus* except the derived *P. polionotus*. Mating preference is a potential barrier to crossing with the allopatric *polionotus*. The absence of any mating-preference barrier to interbreeding of representative, major ecotypes has been recently shown.

The population dynamics are crudely known for a few areas. There is a high degree of dispersal of maturing young up to distances of one-half mile. The movements of adults are localized in a home range. Little is known about local population sizes or about the effects of different kinds of ecological barriers on dispersal.

The present information about this most-studied species gives a vague picture of it as a highly complex system.

## Conclusion

The point of the preceding discussion has been that the attributes of such a complex system as a species have not been, and will not be, revealed by the casual or fragmentary treatment the problem has received from conventional systematics or from ancillary disciplines. The job cannot be done by conventional systematics. I agree with the position of those systematists who hold that the primary mission of systematics is classification, but by so limiting the scope of the field the systematist is ruled out as a major contributor to knowledge of the species as a dynamic system. Furthermore, the modern systematist is plagued by such historical accidents and anachronisms as the present day subspecies concept. If all of the work which has gone into swelling trinomial nomenclature in recent years had gone into scientifically planned studies of geographic variation there would be a much greater knowledge of certain attributes of species.

The time is past due for the development of a school of students of species as the living systems which they really are. Actually the botanists are far ahead of their zoological colleagues in this respect. More and more students of fewer and fewer animal species are needed if there is ever to be a thorough understanding of the species as a dynamic system. Research teams rather than individual efforts may be required for this complex task. The all important thing is that the species must be studied as a living, dynamic system. Both observational and experimental methods are required. Both field and laboratory experiments are necessary. The biometric approach is essential; confidence limits for all observations must be established. Modern

electronics permits accurate measurement of attributes which could be treated previously only in a subjective way. The photo-electric reflection meter replaces subjective color charts for measurement of color; the sound spectrograph is being used to measure voices. Precise, objective measurements of all phenomena are called for.

The measurement, interpretation and understanding of the species as a dynamic, evolving system can qualify as a pretty high kind of biology. The problems are at least as complex as those faced by the biophysicist and other laboratory biologists. The potential contribution to knowledge of the natural world is equally as great as anything the laboratory experimentalist can hope for. The student of the species as a dynamic system need apologize to none of his laboratory-bound brethren.

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# WINTER INVERTEBRATE METAZOA OF GOOSE LAKE, MULESHOE WILDLIFE RESERVE, TEXAS

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ABSTRACT: A taxonomic survey was made of winter (Dec. 21-March 20) invertebrate metazoa of Goose Lake, near Muleshoe, on the Southern High Plains of Texas. Rotatoria were represented by *Brachionus rubens* (Ehrenberg), and *Polyarthra* sp. Arthropoda were represented by *Daphnia pulex* (deGeer) (Cladocera); *Cyclops vernalis* Fisher, *Diaptomus siciloides* Lilljeborg, *D. clavipes* Schacht (Copepoda); *Eucypris* sp. (Ostracoda); *Arrenurus* sp. (Hydracarina); Corixidae sp. (Insecta-Hemiptera); larvae of 2 spp. of Tendipedidae (Insecta-Diptera). Population changes of some of the species are noted.

Taxonomic work on the animals found in bodies of fresh water in western Texas is practically non-existent. Since nothing was known of these aquatic faunas work was undertaken to collect and identify all of the species of invertebrate metazoa in one lake during a specified time of the year.

The body of water chosen was Goose Lake, located on the Muleshoe Wildlife Reserve, 35° 45′ north latitude, 102° 45′ west longitude, elevation 3640 feet. The reserve is on the Southern High Plains near the town of Muleshoe, Bailey Co., Texas. It is rather atypical in structure compared to other lakes in West Texas. It has been made deeper than normal by the building of a dam across one end of a large playa lake. It is about 450 meters long, 100 meters wide at the widest point, and about 1½ meters in depth at the deepest point. In contrast with temporary playa lakes Goose Lake is semipermanent. Only in extremely dry years has it been known to go dry. Since the above conditions create a different habitat from that of a typical playa lake, the fauna of the two can be expected to be different. Goose Lake likewise presents a different habitat from that of spring-fed permanent lakes, a few of which occur in western Texas. This lake is highly alkaline due to the presence of gypsum in the soil. The maximum pH recorded was 9.30; the mean pH, 8.34.

The period of collection and observation was the calendar winter, December 21-March 20, 1954-55. During this time of the year the lake is heavily populated with ducks and geese because of its strategic location in the Central Flyway for migratory waterfowl.

## Materials and Methods

Thirteen collection trips were made at weekly intervals throughout the period of investigation. Specimens were collected with a finely meshed plankton net from two general areas of the lake, the bottom and the shoreline. For collecting along the shoreline, the net was attached to the end of a long wooden pole and then was towed at the surface of the water for a distance of ten to thirty meters. For the collection of specimens from the bottom a sled was constructed which would draw the plankton net at a height of about fifteen centimeters above the mud bottom. This sled was towed behind a rubber raft which was rowed across the deepest part of the lake. Two samples were taken from the bottom each time. Rocks and dead tree stumps in the water near the shore were also studied for the presence of animal life.

Specimens to be kept for further study were either preserved or kept in culture. A variety of ways of killing the specimens was employed. The copepods were killed either by raising the temperature of the water in which they were contained or by overcrowding the specimens until they were killed from lack of oxygen. The latter method proved to be the best if care was taken to remove and preserve the specimens shortly after death.

Rotifers, cladocerans, larval copepods, ostracods, and water mites were first narcotized and then were killed (Pennak, p. 185). Some rotifers were also placed directly into 5-10% formalin which caused the contraction of the animal within the lorica, thus making the details of the lorica easier to study.

Specimens killed by any of the above methods were removed from the killing solution and placed into 70% ethyl alcohol with glycerine added to make 5'-10% of the total. The alcohol was allowed to evaporate slowly until the specimens were thus partially cleared without distortion. The tendiped larvae were killed in Peterson's XAAD solution. The larvae were removed from this solution when expanded and studied in 70% alcohol on depression slides.

Specimens were cultured in glass jars, aquaria, and watch glasses. Those cultured successfully were all the crustaceans and the rotifer, *Brachionus rubens*. The culture medium consisted of distilled water to which a small amount of lake water was added. In no manner could the cultures be termed pure, although each was usually dominated by a single species. The most successful culture containers proved to be glass jars 16 cm. in height and 9 cm. in diameter. All crustaceans were cultured in this type of container. Rotifers were most successfully cultured in watch glasses. These cultures were maintained in order to have abundant material for study at all times.

| Factor recorded | Dec. 23 | Dec. 30 | Jan. 6 | Jan. 13 | Jan. 20 | Jan. 27 | Feb. 3 | Feb. 11 | Feb. 18 | Feb. 25 | Mar. 4 | Mar. 11 | Mar. 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sky coverage | 90% | 0% | 90% | 100% | 0% | 100% | 0% | 0% | 5% | 100% | 0% | 0% | 50% |
| Wind direction | NNE | W | E | WSW | SSW | SW | E | SW | W | W | WSW | WSW | WSW |
| Wind speed f/m | 287 | 1257 | 682 | 400 | 913 | 1020 | 754 | 1154 | 1597 | 675 | 1661 | 2163 | 642 |
| Air temperature degrees C. | 6.25 | 5.0 | 0.0 | -1.0 | --- | 3.0 | 0.0 | 7.0 | 21.0 | 11.0 | 23.5 | 24.0 | 12.0 |
| Water temperature degrees C. | 3.75 | .50 | 5.50 | 3.50 | --- | 3.25 | 3.50 | 2.00 | 11.50 | 7.00 | 15.00 | 13.50 | 14.00 |
| pH of water | 8.58 | --- | 7.80 | 8.20 | 7.75 | 7.80 | 8.10 | 8.42 | 8.75 | 9.00 | 9.30 | 9.10 | 9.30 |
| No. of waterfowl | 75,000 | 60,000 | 40,000 | 2,000 | 4,000 | 20,000 | 3,000 | 100 | 200 | 4,000 | 1,000 | 1,000 | 200 |
| Precipitation | Dec. 28 - .2", Jan. 5 - .6", Jan. 15 - .25" | | | | | | | | | | | | |

Chart I. Environmental factors at Goose Lake during winter of 1954-1955.

Permanent and temporary microscope slides of the various specimens were prepared. The permanent mounting medium used was Hoyer's modification of Berlese's fluid (Baker and Wharton, p. 10). The smaller crustaceans were mounted under cover-slips on standard glass slides; however, the larger specimens had to be mounted on depression slides to prevent distortion by the weight of the cover slip. Crustacean appendages, etc., necessary for identification of the species were removed and mounted. The Rotatoria were most successfully studied in temporary glycerine mounts.

The nauplius stages of *Cyclops vernalis*, a copepod, were studied. Although many nauplius larvae were collected from the plankton, only those were examined which were hatched and reared in the laboratory from ovigerous females which had been isolated in watch glasses. The above method assured that these larvae were those of *Cyclops vernalis* and not those of one of the other copepods from the lake.

For each of several species a graph was designed to show the trend of the population of that species during the collecting period (Chart II). These graphs are not the result of accurate quantitative studies, since the apparatus for such studies was not available, but are the result of purely visual estimations made in the field.

## ROTATORIA

Among the most interesting species of animals to be commonly found in limnetic plankton associations are the rotifers. Three species of rotifers were present in Goose Lake; two were common and one was evidently uncommon. The two common species were identified as *Brachionus rubens* Ehrenberg and *Keratella valga* (Ehrenberg). These two genera are common and widely distributed.

On one occasion a very small, unusual rotifer was found in a group of common rotifers which had been killed and preserved. Generic determination was based on the possession of twelve movable blade-shaped lateral appendages, features characteristic only to the genus *Polyarthra*.

Since observations on populations of the various species were made in the field, little was learned about rotifer populations. Specimens of both *Brachionus rubens* and *Keratella valga* were found throughout the collecting period, although *K. valga* seemed more abundant during the middle of the period than at other times. Females of *B. rubens* were often found to be carrying developing embryos.

## ARTHROPODA

### CRUSTACEA—BRANCHIOPODA

CLADOCERA. Collected on every trip was a large cladoceran, the genus of which is readily identified as *Daphnia*. This genus is large in number of species, many of which are highly variable in form. The taxonomy of the genus has not been satisfactorily worked out and a definite decision as to the correct species could not be reached. One authority on the Crustacea identified the species as *Daphnia psittacea* (Baird), another as *Daphnia pulex* (deGeer). The latter determination was chosen.

*D. pulex* is a common and widelly distributed limnetic cladoceran. In Goose Lake, although it was found on every collecting trip, the number of individuals found each time was extremely small. During the week of March 18 there was, however, a marked increase in its numbers. Only females of this species were found in the lake. Interesting also is the fact that nearly all females found, even those taken from water of 0.5°C. contained young in the brood pouches. Reproduction in Cladocera in water of such low temperature is unusual. Early in the collecting period only very large females were found; later in the season smaller forms made their appearance. The larger females were those which winter over and by parthenogenetic reproduction, produce the new spring generations. These generations are produced in part also by the hatching of fertilized eggs which are contained in ephippia, which in *D. pulex* and closely allied species, separate from the rest of the shell after the animal molts. These ephippia are present in tremendous numbers in the debris washed onto the shore of the lake.

As mentioned, only females were taken from the lake, males being found only in laboratory cultures. Pennak sums up the factors which seem to induce the production of males as (1) crowding of the females and the subsequent accumulation of excretory products, (2) a decrease in available food, and (3) a water temperature of fourteen to seventeen degrees. Observations made in the laboratory substantiate the above. Laboratory cultures, kept at 23°C. become extremely overcrowded and the food supply decreased to almost nothing before males were found in the cultures.

### CRUSTACEA—COPEPODA

The dominant forms of invertebrate metazoa were the copepods which outnumbered all other crustaceans at least one thousand to one. Close examination with the unaided eye revealed three distinct types, based on size and color of the individuals. The most abundant form was a small, translucent one, *Cyclops vernalis* Fischer.

In private correspondence, Dr. H. C. Yeatman said of this species, "These specimens show the typical characteristics of the species when it is matured in cold water, that is largeness of body, slenderization and elongation of caudal rami and segments of swimming feet, and the high spine formulae (3, 4, 4, 4) of the terminal segments of swimming feet exopods." In other correspondence, Dr. H. C. Yeatman states, "*Cyclops vernalis* is quite an adaptable species living in all sorts of pools, lakes, streams from northern Alaska to South America and over most of Europe, Asia and even Africa."

Throughout the collecting period females of this species were found to possess ovisacs. The percentage of ovigerous females rose progressively from a small percent at the beginning of collection to nearly one hundred percent at the end of the collecting period. Throughout the entire collecting period copepodid larvae of this species were abundant. Nauplius larvae were found to be most abundant after the third week in January.

Field examination also revealed a small, translucent to yellowish copepod, *Diaptomus siciloides* Lilljeborg, a species common to many limnetic copepod associations throughout the United States. Although far less abundant than *Cyclops vernalis*, it was common in Goose Lake in fairly uniform concentration throughout the collecting period. Females with ovisacs were not found in the lake; however, when kept in cultures in the laboratory, they readily produced them. Production of ovisacs by females of this species in the laboratory was undoubtedly instigated by the warm temperature of the culture water. No nauplius or copepodid stages of *D. siciloides* were found in the lake. The latter, together with the fact that no ovigerous females were found during the collecting period, suggests that reproduction occurs in either late spring, summer, or early fall.

The most impressive copepod found in the lake was a large, sometimes bright red species, *Diaptomus clavipes* Schacht. The coloration was due to the amount and concentration of oil droplets stored within the body of the animal and varied in this species from translucent to almost solid red. On some collecting trips almost all the specimens of *D. clavipes* possessed red coloration; on other collecting trips practically all individuals were colorless. In fact, so pronounced was this color phenomenon that on a few occasions there were enough red forms present to give a red color to the collecting vial.

*D. clavipes* occurred in about the same relative abundance as did *D. siciloides* at the beginning of the collecting period. During the latter part of the collecting period the number of individuals of *D. clavipes* began to decline. The last collecting trip found the species almost absent. What has been stated about ovigerous females and reproduction of *D. siciloides* applies also to *D. clavipes*.

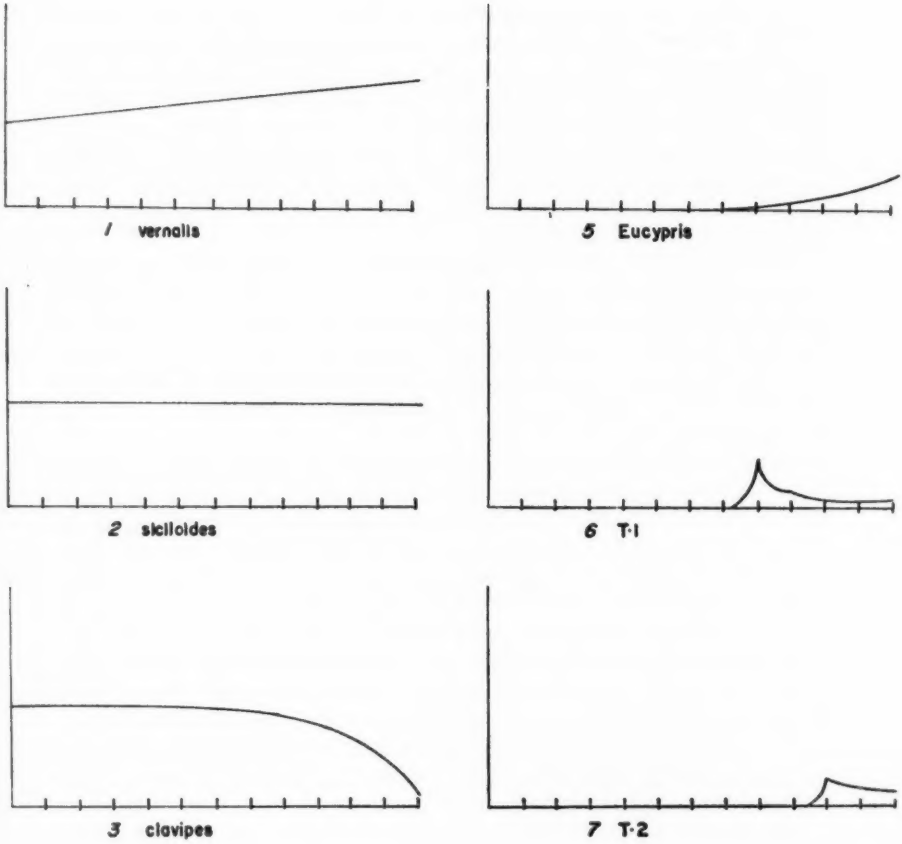


Chart II. Generalized population curves. 1. *Cyclops*. 2-3. *Diaptomus*. 4. *Daphnia*. 5. *Eucypris*. 6-7. *Tendipedidae*.

### CRUSTACEA—OSTRACODA

A species of ostracod, genus *Eucypris*, was found in laboratory cultures long before being found in the lake. Early instars of this animal were first observed in culture and were reared to the adult stage in the laboratory. Because of this observation it was surmised that the first forms to be found in the lake would also be the instar stages. On February 11 specimens of this ostracod were, in fact, found in Goose Lake and, as was expected, were in the forms of early instars. From the preceding facts it can be safely theorized that this species winters over by means of resistant eggs. On the last collecting trip many specimens of this ostracod were found.

Determination of the genera and species of Ostracoda is difficult since little work is being conducted on the group at the present time. Although no definite conclusions could be reached even as to the genus, this ostracod was assigned to the genus *Eucypris*, the one it most nearly seemed to fit.

### ARACHNOIDEA—HYDRACARINA

Among the most unusual animals taken was a species of water mite, *Arrenurus* (Arrenuridae). Only four specimens were taken during the entire collecting period. A male and a female were taken on March 4 and a male and a female were taken on March 11. Curiously, in both instances the females were found near the edge and the males near the bottom. The specimens were dull red in color and opaque.

### INSECTA—HEMIPTERA

Five individuals of a species of water boatmen were found on various occasions throughout the collecting period. In addition to the finding of the adult, eggs were also found in the lake. These eggs occurred singly and in small clusters on the under side of rocks and on dead tree stumps in the water. In the laboratory they proved to be the eggs of the water boatmen. Mr. Billy D. Scott, Teaching Fellow, Texas Technological College, placed the eggs in a diatom culture and they hatched into nymphs several days later.

### INSECTA-DIPTERA

On February 18, the bottom of the lake was found to be heavily populated with large blood-red insect larvae of the genus *Tendipes* (Tendipedidae). Species determination is possible only with the adult of this species, and since no adults were available, only generic determination was made.

The blood-red color of some tendipeds has given to them the common name of blood worms. Although they are bottom dwellers, they occasionally moved up into the plankton by thrashing movements of

their bodies. When brought into the laboratory and placed into copepod cultures they fed voraciously on copepods. Apparently, copepods formed the bulk of their diet in the lake also. These larvae reached a peak in population during the week of February 18. There was a marked decline to almost total absence during the remaining collecting period. Another tendiped larva was found in the lake for the first time on March 4. By March 18, the number of individuals of this species had declined greatly. This larva was colorless and translucent. The individuals of this species were much smaller in size than those of the preceding species. being about 10 mm. in length for the larger and about 3 mm. for the smaller. The latter species was abundant in the plankton, where it apparently remained by thrashing movements of the body and also by adhering to debris floating on or suspended in the water.

## Miscellaneous Observations

These additional notes are concerned with other forms of life present in Goose Lake which were observed, but not further studied.

Protozoans were noticably scarce in Goose Lake, not in numbers of species but in numbers of individuals.

Dormant forms of life such as winter eggs, ephippia, and statoblasts were present in numbers sufficient to be the major constituents of drifts of debris along the shore. Practically all species of animals which were found during this study could also be produced in laboratory culture by placing a small amount of this debris into distilled water and by setting the water aside for several days. Some animals which were not found in the lake were produced in the laboratory in debris-cultures. Among those additional forms were two cladocerans and a bryozoan.

The most abundant forms of life in the lake were not animal at all, but were several species of floating blue-green algae (Myxophyceae), both unicellular and filamentous. The abundance of these algae throughout the period of observation was almost beyond belief. So numerous were they that a white metal plate, when lowered into the water, was completely obscured at a depth of about 8 cms. Certainly these algae were not the only substance in the water contributing to turbidity, but other substances played only a minor role. Numerous species of diatoms were also abundant in the water.

## Summary

A taxonomic survey was made of the winter invertebrate metazoa of Goose Lake, located on the Muleshoe Wildlife Reserve near the town of Muleshoe on the Southern Plains of Texas. The collecting period was December 21 to March 20.

Two major groups of animals among the invertebrate metazoa were represented during the collecting period. The first group, Rotatoria, was represented by three species, *Brachionus rubens* Ehrenberg, *Keratella valga* (Ehrenberg), and *Polyarthra* sp. The second group, Arthropoda, was represented by *Daphnia pulex* (deGeer), a cladoceran; *Cyclops vernalis* Fischer, *Diaptomus siciloides* Lilljeborg, *Diaptomus clavipes* Schacht, all copepods; *Eucypris* sp., an ostracod. Also represented among the Arthropods was one species of Hydracarina, genus *Arrenurus;* one species of water boatman, family Corixidae, and two species of dipteran larvae of the family Tendipedidae.

By field observation the appearance, disappearance, increase and decrease in the population of some of the above species were noted.

## Acknowledgements

For his cooperation during this study, sincere appreciation is extended to Mr. Jim Harmon, Manager of the Muleshoe Wildlife Reserve. Gratitude is expressed to the following persons for confirming the identifications of the animals which were found:

Dr. I. W. Kiser, Centralia Junior College, Centralia, Washington.—Cladocera.

Dr. Robert W. Pennak, Professor of Biology, University of Colorado, Boulder, Colorado.—Cladocera, Copepoda, Rotatoria.

Mrs. Mildred Stratton Wilson, Arctic Health Research Center, United States Public Health Service, Anchorage, Alaska.—Copepoda.

Mr. Willis W. Wirth, Insect Identification and Parasite Introduction Section, Entomology Research Branch, Agricultural Research Service, United States Department of Agriculture, Washington, D. C.—Tendipedidae.

Dr. H. C. Yeatman, Department of Biology, The University of the South, Sewanee, Tennessee.—Copepoda.

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# ADDITIONS TO THE FISH FAUNA OF OKLAHOMA WITH A SUMMARY OF INTRODUCED SPECIES[1]

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ABSTRACT: Report of the collection and distribution in Oklahoma of six fishes not previously recorded from the state (*Salmo trutta, Hiodon tergisus, Ictalurus nebulosus, Typhlichthys subterraneus, Fundulus catenatus, Roccus saxatilis*) brings the total number of species known from Oklahoma to 167. Three of the six represent introduced forms. A list of all exotic fishes known to be introduced into Oklahoma waters, with the available history of introduction, is included. Of the 14 known or postulated to be introduced, 5 are utilized as bait species and 9 were introduced as additional food for game fishes. Eight have had varying degrees of reproductive success; 5 of the game fishes were not expected to provide reproducing populations, and their success is dependent on continual restocking. Only the introduction of the tench, *Tinca tinca*, can be considered unsuccessful.

In 1946, Dr. Carl Hubbs (in Aldrich, 1946) listed 127 species of fishes as occurring in Oklahoma waters. During the past decade extensive fishery surveys by educational and conservation agency personnel in the diversified habitats of the northeastern and southeastern regions of the state have yielded 30 more forms (Moore, 1952). The use of rotenone, gill nets, and electric shockers, sampling equipment not employed by earlier collectors, is undoubtedly responsible for the finding of some of these species. In addition, several exotic fishes have been introduced into state waters, either accidentally through bait sources or for purposes of fisheries management by state and federal agencies. It is the purpose of this paper to report six additional species not previously recorded from state waters—*Salmo trutta, Hiodon tergisus, Ictalurus nebulosus, Typhlichthys subterraneus, Fundulus catenatus,* and *Roccus saxatilis*—and to bring up to date and summarize the available information concerning the introduced fishes.

In addition to the writer, the 1955 field survey crew of the Oklahoma Fisheries Research Laboratory included R. M. Jenkins, J. C. Finnell, Lothar Hornuff, and Ben Pilkington. Messrs. Phil Summers, H. A. McCoy and J. C. Benefield also assisted at various times. Drs. Frank Cross, Kansas University, and Loren Woods, Chicago Natural History Museum, furnished data on the specimen of *Typhlichthys subterraneus* and kindly granted permission for their use. Dr. George A.

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Moore, Oklahoma A&M College, verified the identification of *Hiodon tergisus, Ictalurus nebulosus,* and *Fundulus catenatus.* In addition, he furnished unpublished information concerning some of the introduced fishes and made helpful suggestions with the manuscript.

The following abbreviations are used. UOMZ—University of Oklahoma Museum of Zoology; OAM—Oklahoma Agricultural and Mechanical College; and KU—Kansas University.

SALMO TRUTTA Linnaeus. Brown trout. This species has never been included in any recent list of Oklahoma fishes, but 100 legal-sized brown trout were stocked in Boecher Lake, Blaine County, along with rainbow trout, in the fall of 1951 (Oklahoma Game and Fish News, May, 1952). Furthermore, A. C. Balch (personal communication) Superintendent of the Federal hatchery at Neosho, Mo., stated that the Neosho hatchery furnished 270 four-inch brown trout for planting in Spring Creek near Ada, Pontotoc County in 1950. The results of these plantings have never been determined.

HIODON TERGISUS Le Sueur. Mooneye. The mooneye is one of several fishes which Drs. Carl Hubbs and George A. Moore have long predicted should be found in Oklahoma waters. During a survey of the Little River System in 1955 by Oklahoma Fisheries Research Laboratory personnel, a total of 35 specimens (T.L. range 7.0-10.4 inches) were taken with experimental gill nets in the Mountain Fork River six miles above its confluence with Little River, east of Broken Bow, McCurtain County. All the fishes were collected in a one-mile stretch of river immediately below the bridge on U.S. 70 on 10 different days, June 16 to July 22, 1955. Intensive sampling with seines and rotenone in the entire river system failed to reveal any young mooneye. Following heavy rains on July 18, the catch of mooneye increased from an average of three per net-day to nine on July 19 and immediately decreased again with lowered water level. Representative specimens are deposited at the University of Oklahoma (UOMZ 26163) and Oklahoma A&M College (OAM 5122).

ICTALURUS NEBULOSUS (LeSueur). Brown bullhead. For use of *Ictalurus* see Taylor (1954).

The brown bullhead has not been included in the list of fishes expected to occur in Oklahoma, although the southern form *I. n. marmoratus* is reported from eastern Arkansas (Hubbs and Lagler, 1947). The following specimens were collected in 1955 in the Little River System, McCurtain County, by the Oklahoma Fisheries Research Laboratory Crew. June 29: 5 adults (9.1—12.5 inches), 3 specimens catalogued as UOMZ 26164, Little Pine Lake, 5 S. of Broken Bow in S7,

T7S, R25E. June 30: 2 young (1.5—1.6 inches, OAM 5128), 1 adult (12.6 inches), Feamster Lake, 11 SW. Broken Bow, in S4, T7S, R23E. July 6: 62 young (1.1—2.1 inches, UOMZ), 6 adults (7.9—14.9 inches), Thomas Lake, 7 NW. Idabel, in S12, T7S, R23E. July 7: 3 adults (8.3—13.6 inches) Thomas Lake, 3 young (1.9—2.1 inches) 2 specimens catalogued as UOMZ 26167, 16 adults (9.3—14.1 inches) West Pine Lake. 5 N. Idabel, in S7, T7S, R24E. July 8: 8 adults (9.6—13.9 inches) West Pine Lake. July 15: 1 adult (14.2 inches, OAM 5123) Forked Lake, 7 SE, Eagletown, in S11, T7S, R26E. July 23: 3 young (2.0—2.3 inches UOMZ 26166), small tributary between Lost and West Pine Lakes, 5 N. Idabel, in S12, T7S, R23E. July 28: 3 adults (8.5—14.0 inches), Forked Lake. A total of 113 brown bullheads, of which 70 were young and 43 were adults, were collected during this period. With the exception of one large specimen taken in a gill net at Forked Lake (OAM 5123) all the bullheads were collected by the use of rotenone. Only three of the 113 were collected in a habitat other than oxbow lakes, and these were from a small tributary between two of the oxbows.

Examination of cross sections of the dorsal spines under high magnification showed all of the small specimens (1.1—2.3 inches) to be young of the year. The ages of the adults ranged from two years at 7.9 inches to five years at 14.9 inches.

These lakes are typical of river bottom cutoffs or oxbows of the lowland coastal plain, which are flooded by the overflowing main stream from one to several times a year. They varied in size from one to forty surface acres and range in depth from four to fifteen feet. Of yellowish-brown color, the water was usually transparent only to a depth of 2.0 to 2.5 feet. The pH and M.O. alkalinity averaged 7.2 and 33.6 ppm respectively, and the lake bottoms consisted of mud, leaves, and some rocks. In addition to cypress, sweet gum, and wateroak trees along the banks, the water edges were surrounded by dense stands of either or both buttonbush (*Cephalanthus*) and cutgrass (*Zizaniopsis*), and some *Nuphar, Ceratophyllum,* and *Rotala* were also present. The number of fishes found in each of these lakes ranged from 27 to 35, and included many of the common game, pan and coarse species. In addition to the brown bullhead, other associated species that are known principally from this region and this type of water in Oklahoma included *Amia calva, Notropis maculatus, Fundulus notti, Aphredoderus sayanus, Lepomis punctatus, Lepomis marginatus, Elassoma zonatum, Centrarchus macropterus* and *Etheostoma barratti.*

The brown adult bullheads were readily distinguished from either yellow or black bullheads, which were also present in these lakes, by their mottled appearance, extremely black barbels, slightly notched

caudal fins, and conspicuous barbels on their pectoral spines. The young with their lighter, dusky-colored barbels and more uniform gray to black body coloration were not as easily recognized in the field. The anal ray counts of the Oklahoma specimens averaged 22 (21—24), which is intermediate between those of the black and yellow bullheads.

Bailey (1956) pointed out that there may be considerable clinal variation in anal-ray count and pigmentation in *I. nebulosus*. Following his suggestion that until sufficient data are available to provide understanding of these variations, I am employing only the binomen for the Oklahoma specimens.

TYPHLICHTHYS SUBTERRANEUS Girard. Small Blindfish. A single 18-mm. specimen (KU 3210) was collected April 24, 1954, by Ted Denesha, at Cave Springs, 2 miles west and 1 mile south of Peoria, Ottawa County. The specimen was secured by Dr. Frank Cross of Kansas University and later identified as the small blindfish by Dr. Loren Woods of Chicago Natural History Museum. The fish was found near the mouth of the cave at a time when the water therein was low and clear. On a subsequent visit to the same cave, Cross reported visibility was limited by a strong stream of murky grey water, and he found no additional specimens.

The collection of blindfish from Oklahoma cave waters was not unexpected since they had been known from Missouri and Arkansas for many years. Dr. Woods (personal communication) has specimens of *T. subterraneus* from the Missouri and White River drainages; Dr. Cross has additional Missouri specimens of this species, as well as some *Amblyopsis (Troglichthys) rosea* in the Kansas University Museum. The latter has long since been considered by Dr. George A. Moore as one of the fishes of possible occurrence in Oklahoma.

Unverified reports by various persons who have observed fish in different Oklahoma caves have several times come to the attention of interested workers. "White" fish have been observed by several individuals in the commercialized Alabaster Cavern near Freedom, Woodward County. George Moore visited this cave on one occasion with the express purpose of securing specimens but was unsuccessful because of the commercial activities. I have examined without success the waters in several of the many underground sink holes in Woodward County. At least three reliable reports have come from individuals who have observed fish in a deep cave near Sulphur, in Murray County, but this location has not been thoroughly examined. Other reports of cave fish have come from investigators studying the bats in Greer and Harmon Counties in southwestern Oklahoma. George Moore and I have seen a

fish taken by S. F. Jackson in a cave near Spavinaw Lake, Delaware County, which, except for a black pigment spot on the head and black tips on the vertical fins, is in all respects a yellow bullhead, *Ictalurus natalis*.

FUNDULUS CATENATUS (Storer). Northern studfish. The western extremities of the known range of the northern studfish were reported by R. R. Miller (1955) as being the tributaries of the Red River in southwestern Arkansas, and clear streams of the Ozark Mountains in Kansas, Arkansas and Missouri.

This species, the largest member of the genus in inland waters, has likewise been one of long expected occurence in Oklahoma, but more especially since the June, 1951, collection of several adult specimens by George A. Moore and C. E. Hoffman in Clear Creek, an Illinois River Tributary, 5 miles north of Fayetteville, Arkansas. These specimens constituted the first known record from the Arkansas River System (Hall, 1954). On April 27, 1955, Carl D. Riggs, John King and I found this species still present in Clear Creek, and, although there appears to be no barrier against its southward and westward dispersal through the Illinois River System in Oklahoma, extensive collecting therein since 1952 has failed to reveal its presence.

On August 18, 1954, a crew from our laboratory, making a reconnaissance survey of tributaries on the eastern side of Grand Lake, seined the Elk River at the mouth of Buffalo Creek in Delaware County, 1 mile west of the Oklahoma-Missouri State Line. No fish were preserved, but a member of the crew took kodachrome photographs of the various species collected. Among these was a large *Fundulus*, which, upon later examination of the photograph, I tentatively identified as *F. catenatus*.

On January 22, 1955, Sam Jackson and Virgil Dowell, graduate students at the University of Oklahoma, collected 7 small specimens (36—45 mm., 6 UOMZ 26161; 1 OAM 5129) of *F. catenatus* in Spavinaw Creek, Delaware County, 1.5 miles above the bridge on Highway 10. These were the first known specimens from Oklahoma. On April 28, 1955, the above-mentioned photograph was verified when Riggs, King and I seined 31 young and adults (41—90 mm.), 26 specimens catalogued as UOMZ 26168, in Buffalo Creek, just above its confluence with the Elk River, Delaware County. All of the above specimens were taken in backwater pools of typical clear, rocky Ozark streams, or in the transition area between current and backwater. A single, large adult specimen (106 mm.) was picked up during a rotenone sampling in August 1955, of Woodward Hollow, a cove of Grand Lake, 25 miles downstream from the site of other *F. catenatus* collections in Elk River.

On the basis of an extensive study of the distinction of the fishes of Arkansas by Dr. John E. Black (Ph. D. Thesis, Univ. of Mich., 1940), in which *F. catenatus* was recorded only in the White River System of northwestern Arkansas, but *F. olivaceus* was found common in the Arkansas River Drainage generally, Dr. Robert R. Miller (personal communication) believes that the former may represent a recent bait introduction into the Arkansas River Basin. Considering the fact that this species is used as a bait and knowing the habits of some bait fishermen, together with the absence of any specimens in the many collections from this region prior to 1954, I am inclined to agree that the studfish was probably not native to the Arkansas River Drainage. On the other hand, from personal experience I am aware that even the most extensive sampling of a region leaves no assurance that all the native species have been collected.

Irrespective of its earlier status, the fact that substantial populations of *Fundulus catenatus* now exists in Spavinaw and Buffalo creeks and the Elk River in Delaware County, Oklahoma, is indicated by these recent collections. Spread of these populations through the Arkansas River System will undoubtedly be affected by the large impoundments which exist or are planned downstream. Other possible avenues of range extension in Oklahoma are southwestward in the Illinois River System, and westward in the Red River System through Ouachita mountain streams.

ROCCUS SAXATILIS (Walbalm). Stripped bass. Two thousand striped bass fingerlings were secured from California and planted in Great Salt Plains Reservoir, Alfalfa County, in September, 1955. by the State Game and Fish Department. Their introduuction was part of a management experiment to provide a sport fish that could tolerate the fluctuating salt concentration of this water. Gizzard shad was the only species that survived through the summer of 1955, during which the chloride concentration reached a high of 15,000 ppm. At the same time as the above planting, an additional 1500 fingerlings were stocked in Lake Murray, Carter County.

The addition of these six fishes to the Oklahoma faunal list, together with the reports, since 1952, of *Signalosa petenense* and *Notropis brazosensis* (D. R. Miller, 1955), *Ammocrypta clara* (Linder, in press), and *Astyanax fasciatus* (Riggs, 1954), raises the total number of known and recorded species to 167. Of the recent records, *Hiodon tergisus* and *Fundulus catenatus* were formerly on the expected list of

occurrence in state waters; *Salmo trutta, Roccus saxatilis, Astyanax fasciatus,* possibly *Fundulus catenatus* and *Notropis brazosensis* represent introduced forms. The absence of earlier records for *Signalosa petenense, Ictalurus nebulosus, Typhlichthys subterraneus, Ammocrypta clara,* as well as for *Hiodon tergisus,* can only be explained from inadequate habitat sampling.

With the record of *T. subterraneus* now established, it is logical to assume that, with careful examination of the many cave waters of this state, other blindfish species, notably *Amblyopsis (Troglichthys) rosea,* may eventually be found. Likewise, *Fundulus chrysotus* is known from Louisiana, Arkansas, and southern Missouri (R. R. Miller, 1955), and it should be present in Red River tributaries in the coastal plains regions of extreme southeastern Oklahoma. With more intensive study in this and other areas of the state, the continued use of more efficient sampling equipment, and with the possibility of the introduction, either accidental or controlled, of other exotic species, the list of recorded fishes from Oklahoma can be expected to continue to increase.

## Introduced Fishes

Information concerning the various species introduced into Oklahoma waters is widely-scattered among a few publications and in the files of several government agencies. For some of the fishes, the only knowledge of the initial plantings constituted what could be best remembered by early fish culturists of this state. The meagre information on some bait species, the use of common or local names for sport fishes on state stocking records, and the practice of transplanting by private individuals does not permit a complete history of introduction. Therefore, the following annotated list represents only a compiled summary of the best available information regarding the introduction of exotic fishes into Oklahoma.

1. SALMO GAIRDNERI Richardson. Rainbow trout. The earliest available record of rainbow trout stocking in Oklahoma waters is 1895 (Anon. 1896). Since then both state and federal agencies have planted this species in various streams and lakes of the state. This fish, usually obtained as large fingerlings or adults from the federal hatchery at Neosho, Missouri, has not reproduced, and the results of the plantings has usually amounted to a few catches immediately after stocking and occasional returns throughout the life of the particular population. Recent plantings (1951-1955) in Boecher Lake at Roman Nose State Park, Blaine County; Spavinaw Lake, Delaware County; and in the Illinois River below Tenkiller Dam, Sequoyah County, have produced more returns to anglers, but continued restocking is necessary to maintain each fishery. Two private commercial trout farms, in existence during the previous decade in Ottawa and Adair Counties, have been discontinued.

2. SALMO TRUTTA Linnaeus. Brown trout. Discussed previously in present paper.

3. ASTYANAX FASCIATUS (Cuvier). Banded tetra. This representative of a large family of South American fishes was first reported in Oklahoma from the collection of a single specimen in an island pond in Lake Texoma in 1952 (Riggs, 1954). The possibility of a bait introduction was soon verified by acknowledgement of its sale by local bait dealers, who secured them from Texas. In addition to Lake Texoma, since 1952, *Astyanax* has been sold by bait dealers at, and escaped specimens collected from Lake Murray in south central Oklahoma, and Spavinaw, Fort Gibson, and Tenkiller Lakes in northeastern Oklahoma. Virgil Dowell showed me specimens of small tetra 19-35 mm.), which he collected in Lake Texoma in June and July, 1955. This size fish is much too small for use as bait and indicates possible successful reproduction in 1955, a condition that disputes previous opinions that *Astyanax* would neither reproduce nor overwinter in Oklahoma waters.

4. CYPRINUS CARPIO Linnaeus. Carp. The first definite record of the introduction of carp into Oklahoma is for 1882 (McDonald, 1884). However, it may have already been present in state waters at this time, since earlier plantings had been made in most of the surrounding states (Smiley, 1884). The introduction of the species was apparently terminated after 1896, but the success of the early plantings is substantiated by the fact that carp now occur in most of the rivers and larger lakes of the state. It is presently harvested only by commercial fishermen, and a few sportfishermen, and by Game and Fish Department personnel for improvement of game fishing.

5. TINCA TINCA (Linnaeus). Tench. Baughman (1947) summarized the attempts of the U.S. Fish Commission to stock tench in America in the years 1889-1896. During this period a total of 4,867 fish were planted at Shawnee, in Blue River near Armstrong, Kingfisher Creek at El Reno, and distributed to various private applicants in Oklahoma. These plantings, the only ones known, were apparently unsuccessful, as this species has never been recorded from any state waters.

6. CARASSIUS AURATUS (Linnaeus). Goldfish. Culture and distribution of goldfish by the U.S. Fish Commission was begun about the same time as that of the carp, and the first available stocking in Oklahoma was in 1889 (Anon. 1893). Moore and Cross (1950) recorded wild populations in a natural lake, Payne County, and South Carrizzo Creek, Cimarron County. I have found it occuring sporadically in streams and ponds over the state. The suggestion of Miller and Alcorn (1945) that the widespread use of goldfish as an ornamental aquarium fish and its utilization as a live bait species may have accounted for its distribution in Nevada, is likewise applicable to Oklahoma. During recent years from six to ten commercial goldfish hatcheries have been operating here, and their products have at one time or another been used in most waters of the state.

7. NOTROPIS BRAZOSENSIS Hubbs and Bonham. Brazos River shiner. Hubbs and Bonham (1951) regarded *N. brazosensis*, *N. potteri*, and *N. oxyrhynchus* as being largely endemic to the Brazos Drainage of Texas and interpreted the presence of one, *N. potteri*, in the Red River as the result of the establishment of escaped bait minnows. However, D. G. Miller (1955), in reporting *N. brazosensis* and *N. oxyrhynchus* from the Red River drainage of

Oklahoma and Texas respectively, pointed out the close proximity of tributaries of the Brazos and Red Rivers and the possibility of the movement of these fishes across the divide during torrential rains. Whether these species were naturally distributed into the Red River System or first introduced from bait cannot be determined, but, in the light of their use as bait species, they must be considered among the possible introductions.

8. NOTROPIS POTTERI Hubbs and Bonham. Chub shiner. Discussed under *N. brazosensis* above.

9. FUNDULUS CATENATUS (Storer). Northern studfish. Discussed previously in present paper.

10. ROCCUS SAXATILIS (Walbaum). Striped bass. Discussed previously in present paper.

11. LEPOMIS MICROLOPHUS (Gunther). Redear sunfish. This species was introduced into Oklahoma from Texas and Louisiana by John Murphree, Superintendent of the state fish hatchery at Durant. He stated (personal communication) that he requested a few adults in 1933 and 1934 from different Texas fish hatcheries, but each year received only one male fish. In 1835, he secured 13 pair of adult redear from a club lake near Alexandria, Louisiana. From these brood fish he raised 50,000 fingerlings, of which 32,900 were distributed to various waters in 1935-36, and the remainder saved for brood stock. Since then, this species has been cultured by all state hatcheries and, at present, is widely distributed over the state.

13. STIZOSTEDION VITREUM (Mitchell). Walleye. The walleye may be a native species, since Jordan and Gilbert (1886) reported it from Lee Creek, which is largely in Oklahoma, near Van Buren, Arkansas. However, only the sauger, its near relative, has been reported from eastern Oklahoma streams in recent years. As a fishery management measure, the State Game and Fish Department introduced 500,000 walleye fry into Canton Reservoir, Blaine County, in 1950. These fish grew exceptionally well, some of them attaining the weight of 6.5 pounds by 1954. From this planting, the species was distributed by bait dealers, who seined the North Canadian River below the lake, and transferred them to other waters, including Lake Carl Blackwell, Payne County. Since 1950, additional plantings of walleye have been made by various governmental agencies in Grand, Tenkiller, Fort Gibson and Greenleaf lakes in northeastern Oklahoma; in lakes Hiwassee and Hefner in central Oklahoma, and in Pennington Creek, tributary above Lake Texoma, in the southern part of the state. There has been no evidence of reproduction from the planted fish.

14. PERCA FLAVESCENS Mitchell. Yellow perch. The history of the introduction of yellow perch into Oklahoma waters has been adequately discussed by Moore and Cross (1950). However, I should like to point out that the population reported by them from Mountain Lake, Carter County, and the one known from Ardmore City Lake below the above impoundment, were probably destroyed in rotenone kills by the State Game and Fish Department in 1953. As late as August, 1954, a small reproducing population was known to be still present in Pawhuska Lake, Osage County.

Of the fourteen fishes known or postulated to be introduced into Oklahoma, there are two salmonids, one characin, five cyprinids, one cyprinodont, one serranid, two centrachids, and two percids. Five of the fourteen—*Astyanax fasciatus, Carassius auratus, Notropis brazosensis, N. potteri,* and *Fundulus catenatus*—are utilized as bait species, and the occurrence and present distribution of at least one (*Astyanax)* is known, and the others considered to be the indirect result of such use. The goldfish is the only bait fish known to have been planted in any state waters. The remaining nine exotics were introduced at various times by city, state and federal governments as sport or food fishes.

Eight of the introductions have had varying degrees of success, if reproduction is considered the determining criterion. Carp and redear sunfish are now widely distributed over Oklahoma; a few wild populations of goldfish have becore established; yellow perch have maintained small populations in several lakes; and series of tetra (one lake), Brazos River and chub shiners, and studfish have been collected.

Five of the exotic forms, brown and rainbow trout, walleye, striped bass, and yellow-belly sunfish were introduced to provide additional sport fishing, and reproducing populations were not necessarily expected. In this respect, the introduction of rainbow trout and walleye has produced the desired results, as did that of yellow-belly sunfish, until stocking of it was discontinued. The success of the brown trout stocking was never adequately investigated, but its present status is doubtful. Sufficient time has not elapsed to determine the results of the stripped bass planting.

The introduction of tench into Oklahoma waters during the latter part of the last century can be considered unsuccessful.

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# NEW RECORDS OF SNAKES IN SOUTHWESTERN KANSAS

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ABSTRACT. Four species are reported from 3 counties. COLUBRIDAE: *Natrix r. rhombifera* Hallowell, *Heterodon n. nasicus* Baird & Girard (both Seward Co.). CROTALIDAE: *Sistrurus catenatus* Raf. (Meade Co.). *Crotalus v. viridis* Raf. (Finney Co.).

During the summer of 1955 a small collection of amphibians and reptiles was made in Meade and surrounding counties in southwestern Kansas. Included were four new county records, two of which represent small but important range extensions. Specimens have been deposited in the collection of the University of Arkansas Department of Zoology (UADZ); they were collected by the writer unless otherwise stated.

## COLUBRIDAE

NATRIX RHOMBIFERA RHOMBIFERA Hallowell. Diamond-back Watersnake. (UADZ 1684.)

Captured August 4, about 1:30 P.M., in a reed habitat along the Cimarron River, about 5.8 miles southwest of Kismet, Seward County. The water was backed up into a small ravine by a beaver dam. This locality extends the known range of this snake in Kansas westward by about 18 miles (cf. Smith, 1950; 266).

Female. Body length 855 mm., tail length 209 mm. Supralabials 8-8, infralabials 11-11; dorsal scale rows 25+27+21, ventrals 137, subcaudals 58. Ground color light brownish gray with 33 gray-black middorsal blotches on the body connected by narrow, indistinct, dark, alternating lines in a row on either side. Belly yellowish white with numerous semilunar blackish spots on the anterior borders of most of the ventral plates.

HETERODON NASICUS NASICUS Baird & Girard. Western Hognose Snake. (UADZ 1685.)

Taken July 19, about 9:15 A.M., on a dirt road 6.2 miles southwest of Kismet, Seward County. This locality helps to fill an apparent gap in the distribution of this species in Kansas (cf. Smith, 1950: 220).

Female. Body length 556 mm., tail (broken off) 84+mm. Rostral projecting forward, sharply turned up, with a single median keel. Supralabials 8-8, infralabials 10-10; dorsal scale rows 23+23+19, ventrals 149, subcaudals 36+. Ground color pale yellowish brown with a mid-dorsal row of 49 dark blotches on the body and 11 on the tail, tending to form crossbands. Two rows of alternating blotches present on either side, the area between the blotches pale brownish white. Belly yellowish with a wide, irregular band mid-ventrically, interrupted by spots of yellow and white. The above description agrees with Edgren's (1952: 2) definition of this subspecies.

## CROTALIDAE

SISTRURUS CATENATUS Rafinesque. Massasauga. (UADZ 1686.)

Killed June 30, approximately 3.5 miles south of Meade County State Park, Meade County, by Dr. Claude W. Hibbard. It was found about dusk on a dirt road. Both Tihen and Sprague (1939: 505) and Smith (1950: 298) thought that this snake would eventually be found there. Gloyd (1955: 95) records an individual from Harper County, Oklahoma, some 29 miles to the southwest. This is the nearest recorded locality.

Male. Body length 398 mm., tail length 55 mm.; four rattles present. Supralabials 11-12, infralabials 13-13; dorsal scale rows 23+23+17, ventrals 144, subcaudals 29. Ground color gray-brown with 37 recognizable, squarish, black body blotches with fine white borders; blotches are about twice as large as the spaces between. Tail blotches 5. Belly moderately blotched with brownish gray, especially laterally.

The color pattern, both dorsal and ventral, is characteristic of *S. c. tergeminus* Say, as defined by Gloyd (1955: 94). The scutellation of the labials, ventrals, and subcaudals might refer either to this subspecies or to *S. c. edwardsi* Baird & Girard, which the small dorsal scale counts strongly suggest. Since this individual was collected between the known ranges of the two two subspecies, and since it combines the distinguishing characters of each, it may be considered a member of an intergrading population *S. catenatus tergeminus* × *edwardsi*.

CROTALUS VIRIDIS VIRIDIS Rafinesque. Prairie Rattlesnake. (UADZ 1687.)

Mr. Marvin Schwilling presented me with a Prairie Rattlesnake which he killed June 9, in the Buffalo Pasture of the Finney County State Farm Preserve, about 2 miles southwest of Garden City, Finney County. This record helps to fill an apparent distribution gap (cf. Smith, 1950: 304).

Male. Body length 495 mm., tail length 41 mm.; 5 rattles and a button present. Subcaudals 14-15, infralabials 17-16; dorsal scale rows 25+25+19, ventrals 173, subcaudals 25. Sides of head dark brown with characteristic diagonal white lines; a fine transverse line present over each eye on the top of the head. Ground color of body gray with 40 oval, white-edged dark blotches; tail with 7 cross bands. Belly immaculate, brownish gray.

I wish to thank Dr. Claude W. Hibbard, University of Michigan Museum of Pateontology, and Mr. Marvin Schwilling, Kansas State Forestry, Fish and Game Commission, for donating the crotalid specimens. Also thanks are given to Dr. Hibbard and to Dr. Herndon G. Dowling, University of Arkansas Department of Zoology, for valuable suggestions.

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THE SOUTHWESTERN NATURALIST 1 (1) : 30—34 JANUARY, 1956

# COLOR VARIATIONS OF GROUND SQUIRRELS (CITELLUS MEXICANU S, SCIURIDAE) IN TEXAS

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ABSTRACT. An examination of 44 specimens of *Citellus mexicanus parvidens* (Mearns) from south, central and west Texas with a reflection meter shows that there is a statistically significant difference in pelage color. West Texas specimens in general are significantly lighter than those from central and south Texas. This is assumed to be the result of response to a particular type of environment (soil coloration), resulting from the pressure of natural selection.

At present, ground squirrels of the species *Citellus mexicanus* (Erxleben) are divided into two subspecies (Howell, 1938). The subspecies *mexicanus* is the southern form and is confined entirely to central Mexico. The subspecies *parvidens* (Mearns) is the northern form and occupies a geographic range extending from northeastern Mexico into Texas and New Mexico, at least as far north as Dickens County, Texas. (Northern limits of range in Texas are based on specimens in the University of Texas Natural History Collection.) The main morphological differences between these two subspecies is that *parvidens* is smaller in size and paler in color than *mexicanus*. Howell (1938) recognized that there is a considerable amount of color variation within both subspecies but apparently believed that these differences did not justify the description of additional races. This paper is a report of color variation within the subspecies *parvidens*. I am indebted to Dr. W. F. Blair for critically reading the manuscript.

Because *Citellus m. parvidens* occupies a considerable and diverse geographic area it would be expected that these animals would exhibit to some extent, diverse morphological characters. An examination of 44 specimens of *C. m. parvidens* from Texas confirmed this hypothesis and the earlier observations of Howell, at least as far as color is concerned. The difference in color of the specimens from one general area to another is, in some cases, pronounced enough to be readily visible without optical aids.

In order to obtain an accurate measurement of the amount of color variation, each specimen was analyzed with an electric reflection meter using reflected red, green and blue light. All measurements were taken on the mid-dorsal line directly between the points of the shoulders.

Only adult specimens in good pelage condition were used. It was found that if the same specimen was measured two different times there was a slight variation in the reading of the reflection meter. This slight difference in reading was apparently due to the nature of the color pattern of these rodents and the nearly impossible ability to place the reflection meter tube in precisely the same place each time. Consequently each specimen was measured three times with each filter and the average of each filter reading was used in the calculation of the data as shown in Table 1 and by Figure 1.

Specimens were available from the following localities in Texas (number of specimens shown in parentheses): *South Texas:* Bee Co., 10 mi. W. Beeville (3); Hidalgo Co., 6 mi. S. McAllen (3), 12 mi. N.E. McCook (1); Live Oak Co., 2 mi. W. Oakville (4); *Central Texas:* Kerr Co., Kerrville (3); Travis Co., Austin (Zilker Park) (3), 1 mi. N.W. Austin (1); *West Texas:* Crockett Co., 15 mi. N. Sheffield (1); Dawson Co., 10 mi. E. Lamesa (5); Dickens Co., 14 mi. W. Guthrie (1); Fisher Co., 12 mi. E. Hermleigh (2); Howard Co., 7 mi. N.E. Big Spring (1); Terrell Co., 1 mi. S. Sheffield (2), 14 mi. S. Sheffield (7), 15 mi. S. Sheffield (3), 16 mi. S. Sheffield (2), 20 mi. S. Sheffield (1); Tom Green Co., 2 mi. S. San Angelo (1).

It will be noticed that for purposes of convenience and statistical treatment the specimens are somewhat arbitrarily lumped into three groups. In general, the distribution of these groups follow natural and ecological boundaries. The South Texas specimens are from an area classified by Blair (1950) as the Tamaulipan Biotic Province, the Central Texas specimens were collected in the Balconian Biotic Province and the West Texas individuals were largely collected in the Kansan Biotic Province. Figure 1 is a graphical presentation (after Dice and Lerras, 1936) of the data shown in Table 1. The extreme limits of variation are represented by a single vertical line. A bar across this line represents the mean. Double lines extending above and below this crossbar to other crossbars represent two times the standard error of the mean above and below the mean. According to Dice and Lerras (1936), if the rectangles of any two lines do not overlap in vertical position on the graph, the difference between the two means is probably of statistical significance.

It can be seen in Figure 1 that for each of the color readings, a pattern is fairly well expressed. In general, the Central Texas specimens reflected the least amount of light, indicating that they are the darkest in color of the three groups. The West Texas specimens are the lightest in color because they gave the highest readings, although there is not

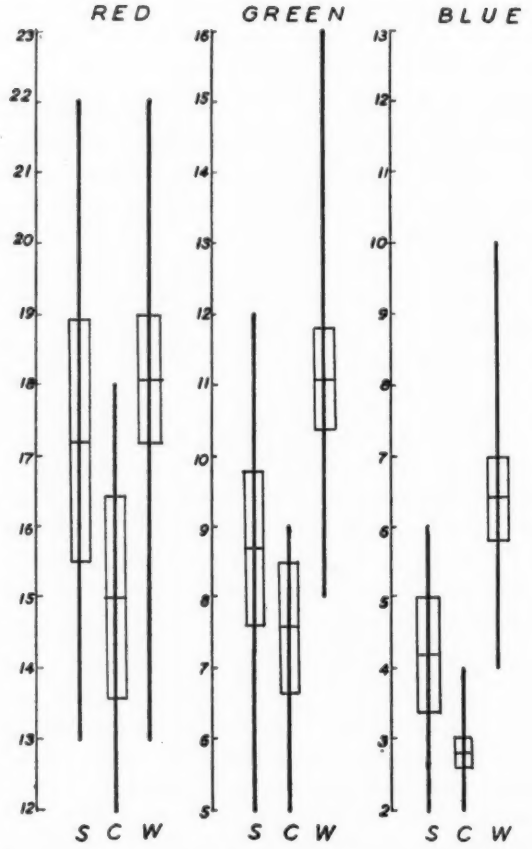


Figure 1. Graph of amount of reflected red, green and blue light from skins of populations of ground squirrels from South Texas (S), Central Texas (C) and West Texas (W). Explanation of figure is in text.

| | *Red* | *Green* | *Blue* |
|---|---|---|---|
| South Tex. (11) | 17.18±.85 | 8.72±.56 | 4.18±.40 |
| Central Tex. (7) | 15.00±.67 | 7.57±.48 | 2.85±.07 |
| West Tex. (26) | 18.07±.46 | 11.03±.37 | 6.38±.31 |

Table 1. Means and standard error of means of amount of reflected red, green and blue light from skins of *C. mexicanus parvidens* from three regions in Texas. (Number of specimens shown in parentheses.)

always a significant difference between them and the specimens from South Texas. The South Texas specimens are apparently intermediate in color between the West and Central Texas specimens.

It is well known that most animals tend to resemble their backgrounds (Dice and Blossom, 1937). Because ground squirrels are terrestrial animals it would be expected that variation in soil coloration would probably be expressed in the color of the pelage. The areas from which the specimens in the present study were collected exhibit somewhat diverse soil types. The South Texas specimens were occurring on soils that are dark brown or black in color (Soil Survey Division, 1938). With the exception of the amount of reflected blue light there is no significant difference between the color of the South Texas and the Central Texas populations. Both regions are characterized by soils of similar coloration and no significant difference in pelage coloration of the two populations would be expected. The soils of the plains area are generally of a reddish chestnut color. This is reflected in the coloration of the West Texas specimens which is consistently lighter than the coloration of individuals from other parts of the state. No consistent or significant skeletal differences were apparent in any of these specimens.

It would seem that in the situation considered above the variation in color is simply the result of a response to a particular type of envorinment (in this case the color of the soil) resulting from the pressure of natural selection. There is no evidence that members of the subspecies *parvidens* are isolated from each other in any manner other than distance. Consequently they must be regarded as members of one more or less continuously distributed population.

Because there are no noticeable differences other than color among the three populations considered above, and other subpopulations of this subspecies with significant color differences probably exist, there seems to be no particular reason to propose formal subspecific names to delimit them. This is in agreement with the ideas recently expressed by Burt (1954), Sibley (1954) and others. Attention is simply called to the fact that there is a statistically significant difference in pelage color among at least two subpopulations of ground squirrels now considered under the taxonomic category: *Citellus mexicanus parvidens.*

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# TWO NEW SPECIES OF BARBULA (MUSCI) FROM THE SOUTHWEST[1]

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ABSTRACT. *Barbula (Streblotrichum) whitehouseae* from north central Texas and *B. (Helicopogon) haringae* from southeastern Arizona are described and named as new.

BARBULA (STREBLOTRICHUM) **whitehouseae**. n. sp. (Fig. 1-4.) Small plants in dull, yellow tufts. Stems about 2-3 mm. high, erect, simple or branched by innovations, radiculose only at base. Stem leaves loosely erect and contorted when dry, erect-spreading when moist, becoming larger above, 1-2 mm. long, lingulate to oblong-lanceolate, keeled, acute or obtuse, ending in a minute, pellucid mucro consisting of a single, smooth, pointed cell; margins narrowly recurved from above the base to the middle or somewhat above; costa strong, papillose at back, terete and dorsally prominent, red-brown, slightly excurrent, in section of upper part of leaf showing 2-4 median guide cells and two stereid bands; upper cells 7-9$\mu$, irregularly hexagonal, rather thin-walled, obscure, bearing on either surface 2-4 C-shaped papillae, basal cells oblong, thin-walled but firm and about 2:1 in lower leaves, laxer and 2-4:1 in upper and perichaetial leaves. Dioicous (antheridia not seen); perichaetial leaves erect and loosely sheathing, oblong-lanceolate, acute to obtuse, minutely mucronate, costate, papillose above, up to 2.5 mm. long. Setae slender, bright yellow, slightly twisted to the left when dry, 10-15 mm. long. Urn of capsule erect, pale-brown, cylindric, 1.5-2 mm. long; operculum conic-rostrate, 1.0-1.2 mm. long; annulus broad and revoluble; peristome (nearly mature) colorless, divided to a low basal tube into filiform, finely papillose divisions closely twisted in at least one spiral.

On soil, Lake Crockett, about 12 miles north of Honey Grove, Fannin Co., Texas, *Eula Whitehouse* 21001, March 29, 1949, type. On shaded, sandy soil, Post Oak Belt, near Christman place, Eagle Mountain Lake, Tarrant Co., Texas, *Whitehouse* 17984, Apr. 6, 1947. Both specimens are in the herbarium of Southern Methodist University, duplicates at the National Museum of Canada.

[1] Published by permission of the Chief Curator of the National Museum of Canada.

Planta pusilla, lutea, caespitosa. Caulis erectus, 2-3 mm. altus, dense foliosus, simplex vel innovando ramosus. Folia sicca erecto-crispula, madida erecto-patentia, 1-2 mm. longa, lingulata vel oblongo-lanceolata, acuta vel obtusa, minute mucronata, canaliculata, marginibus mediis anguste revolutis, cellulis 7-9 $\mu$ latis, hexagonis, papillosis, basi oblongis, laevibus, luteis, costa fusca, valida, minute excurrenti, dorso papillosa. Dioica; folia perichaetialia usque ad 2-3 mm. longa, erecta, laxe concoluta, oblongo-lanceolata, acuta vel obtusa, breviter mucronata, cellulis superioribus papillosis. Pedicellus 10-15 mm. longus, flavidus. Capsula cylindrica, erecta, 1.5-2 mm. longa; annulus latus, revolutus; operculum conico-rostratum, 1-1.2 mm. longum; peristomium dentes valde contorti, membrana basilari brevi.

I am pleased to dedicate this interesting species to Dr. Eula Whitehouse, who is well known for her collections and publications on the flora of Texas. It was she who recognized its peculiarities and sent material to me for study.

The chief diagnostic features of *Barbula whitehouseae* are its yellow setae, an unusual characteristic of this genus, its minutely apiculate leaves and its enlarged, erect and loosely sheathing perichaetial leaves which are structurally quite similar to the upper cauline leaves. Its nearest relatives appear to be *Barbula convoluta* Hedw. (widely distsributed in eastern North America, and west of the Rocky Mountains) and *B. eustegia* Card. & Thér. (Northwestern U.S.). In both of the latter, however, the perichaetial leaves are greatly differentiated in size and shape and are more tightly convolute-sheathing, and the costa does not end as a minute, pellucid apiculus as in *B. whitehouseae*.

BARBULA (Helicopogon) **haringae** n. sp. (Fig. 5-8). Plants dull green, brown below, in low, dense mats on damp rocks. Stems erect, up to 1.5 cm. high, red-brown, forked by repeated innovations, bearing in axils of leaves numerous, dark, red-brown, ovoid, multicellular propagula about 47-88$\times$61 $\mu$ on short, pale stalks. Leaves erect, folded and contorted or twisted around the stem when dry, loosely erect when moist, 1.5-2 mm. long, oblong-ligulate to oblong-lanceolate, acute to obtuse, abruptly cuspidate; margins plane and entire except for papillae but somewhat sinuate and undulate; costa 51-64 $\mu$ broad at base, tapered upward, shortly excurrent; upper cells obscure, densely and minutely papillose, quadrate-hexagonal, 5-6 $\mu$ in diameter, thin-walled, lower cells pale, smooth, short-oblong with firm but not incrassate walls. Dioicous; perichaetial leaves scarcely differentiated; perigonia and sporophytes not seen.

Caulis erectus, furcatus, ad 1.5 cm., in axillis foliorum propagula magna ovoidea, numerosa, ex rubre subnigra gerens. Folia madida laxe erecta sicca contorta vel subspiraliter contorta, 1.5-2 mm. longa, oblongo-lingulata vel oblongo lanceolata, acuta vel obtusa, abrupte el valde apiculata, marginibus plana et integra, costa basi 51-64 $\mu$, attenuata, breviter excurrenti, rete opaco, cellulis supernis minute denseque papillosis, quadrato-hexagonis, 5-6 $\mu$ latis, infime breviter oblongis, laevibus, pellucidis, parietibus firmis; folia perichaetialia similia. Dioica; caetera desunt.

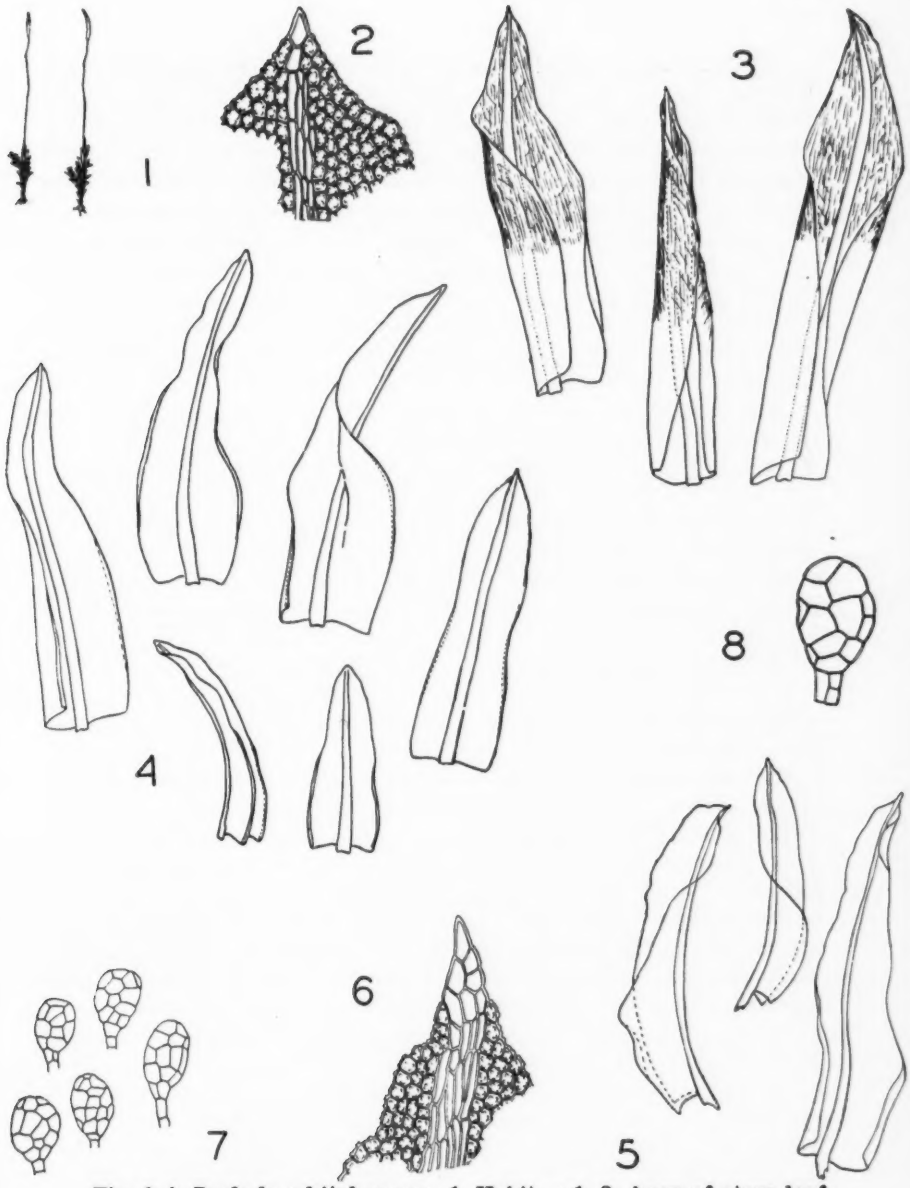


**Fig. 1-4.** ***Barbula whitehouseae.*** **1. Habit, ×1. 2. Apex of stem leaf, × 192. 3. Perichaetial leaves, × 22. 4. Stem leaves, × 22.——Fig. 5-8.** ***Barbula haringae.*** **5. Stem leaves, × 22. 6. Apex of stem leaf, × 192. 7. Propagula, × 90. 8. Propagulum, × 192.**

On damp rock, east slope of mountain west of Huachuca Military Reserve, Cochise Co., Arizona, *Leslie N. Goodding* Cry. 85 (*Haring* 10,000), Oct. 31, 1949, type. On moist rocks, 6000 ft. alt., South Huachuca Canyon, Huachuca Game Preserve, *L. N. Goodding* Cry. 285 (*Haring* 10285a), Cry. 293 (*Haring* 10293), Feb. 24, 1950. All specimens are represented in the herbarium of the National Museum of Canada and the University of Arizona; the type is at the National Museum of Canada.

This species has been named for Mrs. Inez M. Haring, who has long studied the mosses of Arizona and greatly enriched our knowledge of the Arizona flora by her collections and those made by her friends whom she has encouraged to collect. Mrs Haring is responsible for having called these specimens to my attention.

The remarkable features of these plants are the strong apiculus formed by the excurrent costa, the plane leaf margins and, most particularly, the large numbers of stalked, ovoid propagula in the axils of the leaves. The propagula are numerous enough and large enough to be seen under the low magnification of a handlens. The characteristics given above are so distinctive that, even though the plants are sterile, it is felt that there is no question of their true relationship and little danger of not being able to identify to the same species any fruiting material discovered in the future. A diligent search of the literature and careful comparisons of all the Mexican, North American and other species which might possibly be allied to this species have failed to reveal any more closely related than *B. unguiculata* Hedw., of rather wide distribution in eastern North America; the latter is clearly distinct, however, in having leaf margins recurved in the lower half, a much smaller apiculus and no propagula on the stems. *Barbula hypselostegia* Card. of Mexico has a similar aspect and leaves of the same general outline with plane margins, but it has very minutely apiculate leaves, pale, fleshly propagula and greatly enlarged perichaetial leaves. *Barbula cruegeri* Sond. of tropical America might also be confused with *B. haringae*, but its leaves have margins revolute below and end in a much smaller apiculus, and its propagula are smaller.

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# GINORIA DAVISII (LYTHRACEAE), A NEW SPECIES FROM VERACRUZ, MEXICO

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ABSTRACT. Shrub or small tree related to *G. nudiflora* (Hemsl.) Koehne; holotype in Herb. University of Texas.

In the spring of 1955 a species of *Ginoria* was collected in the lowlands of central Veracruz State by Mr. Irby Davis and Mr. Edgar B. Kincaid, Jr. The specimens abundantly represent both flowers and foliage. In several respects they do not answer to published descriptions of other members of the genus. The author is happy to dedicate the new species to Mr. Davis, of Harlingen, Texas, widely known for his field studies of birds in southern Texas and in Mexico, and an accomplished amateur botanist. In recent years he has concentrated on Mexican plants important in avian ecology, and has collected valuable and interesting material.

GINORIA **Davisii**, sp. nov. Frutex vel arbuscula decidua inermis glabra ramis foliisque oppositis. Folia sessilia vel brevissime petiolata laminis simplicibus integris lanceolatis tenuibus breviter acuminatis 4—6(—8) cm. longis 1.4—1.9(—2.5) cm. latis pinnate nervosis. Flores breviter racemosi in ramis sub anthesi nudis; racemi (3—)4—7(—12) flores, pedicelli graciles (1.8—)2.0—2.5(—4.0) mm. longis in bractearum minutarum axillis solitarii apice bibracteolati bracteolis persistentibus (0.7—)0.8—1.0 mm. longis. Flores 4—5-meri. Calyx hemispherico-campanulatus 4.8—6.0 mm. longus (basi brevissime tubulosa quasi stipitata 1 mm. longa inclusa) lobis valvatis demum patulis vel reflexis 2.8—3.2 mm. longis lanceolato-triangularibus acutis. Petala tenuissima spatulata vel obovata basin versus attenuata pallide incarnata vel albescentia. Stamina 12—16; filamenta 3.0—4.5 mm. longa. Ovarium uniloculum vel septis incompletis sub-3—4-loculum. Capsula 4—5 mm. longa 3—4-fida; semina multiseriata numerosissima.

Unarmed, deciduous shrub or small tree up to 5 m. tall, glabrous throughout. Branches and leaves opposite, on some stems dessucate, with more or less prominent nodal buttresses. Branches terete or nearly so. Terminal buds of young branches easily broken off, the branches with their simple leaves then simulating even-pinnate compound leaves. Leaves sessile or very short-petioled, simple; blades thin, entire,

lanceolate, acute at base with a minute dilation at the petiole, short-acuminate at apex, 4—6(—8) cm. long, 1.4—1.9(—2.5) cm. wide, pinnately veined, the veins narrow, whitish, very slightly raised on the lower surfaces. Stipules minute or none. Flowers in very short racemes, appearing in March at the axils of the previous year's leaf-scars, the branches leafless in anthesis; racemes at first very short, appearing as sessile umbels, the leafless flowering branch then appearing to be an interrupted panicle. Bracts minute, scale-like, thickened, 0.3—0.4 mm. long, rounded at apex, some of them round-keeled on back, pedicels solitary in the axils of the bracts; most of the pedicels deciduous with their flowers as the apical bud of the raceme-axis elongates into the leafy, slender spring branch, the old bracts slightly accrescent laterally as the new branch increases in girth and a few flowers persistent into April as the leaves appear. Racemes (3—)4—7(—12)-flowered. Pedicels slender, (1.8—)2.0—2.5(—4) mm. long, bibracteolate at the apex; bracteoles persistent, (0.7—)0.8—1 mm. long, oblanceolate or linear with dilated tips, rounded at apex. Flowers 4—5—merous, actinomorphic. Calyx gamosepalous, 4.8—6 mm. high, the base tubular for about 1 mm., the remainder hemispheric-campanulate; lobes 2.8—3.2 mm. long, valvate in bud, spreading or reflexed in anthesis, lanceolate-triangular, acute; calyx costate without below the angles of the lobes (below the insertion of the petals), with a single median nerve on each lobe, continuing below. Petals alternate with and inserted near the angles of the calyx lobes, crumpled in bud, very thin, spatulate or obovate and much attenuate at base, rounded or slightly acute at apex, erose, (4.4—)5.0—5.6 mm. long, fresh coloration pink or so pale as to be almost white. Stamens 12—16, inflexed in bud, about 3 times as numerous as petals or calyx lobes, emerging from a narrow ring inserted near the top of the calyx tube slightly below the insertion of the petals; filaments 3.0—4.5 mm. long. Ovary superior, sessile or nearly so, 1-celled or incompletely 3—4-celled by membranous septa; style 1, simple, terminal, 5.4—6.1 mm. long, tardily deciduous after anthesis; stigma simple, terminal, capitate, not much wider than style. Fruit a dry, thin-walled, slightly coriaceous, subglobose or often slightly elongate capsule about 4—5 mm. long, opening along 3 or 4 sutures opposite the incomplete septa (pseudosepticidally dehiscent). Seeds very numerous, in many rows between the incomplete septa radiating from the large, central, axile placenta which is not connected to the top of the ovary.

Known only from the type material, collected by L. Irby Davis and Edgar B. Kincaid, Jr., No. 55-8, "about 40 miles north of Chachalacas, Veracruz," March 29, 1955 (HOLOTYPE in Herb. University of Texas;

isotypes, Instituto de Biologia, Mexico; Southern Methodist University). Mr. Davis notes *(in litt.)* that the distance "40 miles" is an approximation by road, and that judging from maps the airline distance is about half that much; the locality is about 10 miles south of the lighthouse near Punta Delgado. Mr. Davis notes further that the species was quite common for miles in the vicinity, and was in heavy bloom, the blossoms attracting many insects. The coastal lowland vegetation at and around the type locality is short forest of the subhumid monsoonal type, deciduous in the long dry season and leafing out when spring rains fall. *Ginoria Davisii* is a small tree with a slender trunk and "not too dense" top, about 15 feet tall at most, or often occurring as a shrub under the larger tree species.

Only one other *Ginoria* has been reported from continental North America. Hemsley (Diagn. Pl. Nov. Mex. 13, 1878) described *Antherylium nudiflorum* from a specimen collected somewhere in southern Mexico by Jurgensen (No. 956, at Kew; not seen). Hemsley included the species in his larger work (Biol. Centr.-Am. Bot. 1: 449, 1880), with an illustration (1. c. 5, Tab. 27, 1888). Koehne (Engler's Bot. Jahrb. 3: 351, 1882) submerged *Antherylium* in a larger genus, *Ginoria*, a West Indian group with *G. nudiflora* as its only continental representative.. He later offered an expanded description (Das Pflanzenr. IV. 216: 251, 1903), with an expanded description based on the only known specimen. Standley (Contrib. U.S. Nat. Herb. 23 pt. 4: 1026, 1924) followed Koehne's treatment, but noted that he had seen another specimen, collected by Galeotti in 1845, probably in Oaxaca. Recently Dr. Faustino Miranda, on the basis of his field observations and No. 7184 of his personal collections (seen by me), has described the ecological occurrence, habit, foliage, and mature fruit, previously unknown (La Vegetacion de Chiapas 1: 99, 1952; 1.c. 2: 188, 1953; An. Inst. Biol., Univ. Nac. Aut. de México 24: 87-88, 1953). Miranda also has another collection probably of *Ginoria*, his No. 4728, a leafy branch, collected near the Rio Papaloapan along the newly paved road from Ciudad Aleman to Cosamaloapan, Veracruz.

*Ginoria Davisii* may be distinguished from the closely related *G. nudiflora* (Hemsl.) Koehne as follows:

Shrub or small tree rarely over 5 m. tall; stamens 12—16; less than 4 mm. long ..... *G. Davisii*

Large tree often as much as 33 m. tall; stamens (26—)28—30; pedicels (5—)9—13 mm. long ..... *G. nudiflora*

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## REVIEWS

**THE ONTARIO FIELD BIOLOGIST. Published by The Toronto Field Biologists' Club. Editor: D. Monty Wood, 7 Dale Ave., Toronto, Ontario, Canada. Published in May and November. Subscription price, $1.00 per year; single copies 50¢.**

Here is a publication to gladden the heart of the field naturalist. In a large city, in a long-settled, long-studied region, in an age dominated by microscopes, chomosomes, and statistics, it borders the miraculous to find a journal sprung from spontaneous, pleasurable, yet serious interest in natural history. The gray cover, largely filled by a bled-off habitat sketch of ptarmigan, with title above in simple gothic letters printed in wine-red attracts at once. Text consists of 30 pages (1 blank), 6x9 inches, reproduced in multilith from typescript, with non-justified margin. There is a frontispiece photograph (action shot of young short-eared owl about to strike a lemming), plus several diagrams and Setonesque sketches—an exceptionally fine one of arctic fox). Contents include an editor's introduction, followed by 6 main articles each 1 to 5¼ pages in length, and 12 shorter notes. Typing and reproduction are almost flawless. Illustrations are well executed and pertinent to the text. There is an error in the legend for that of the sea lamprey: marked "×3," it is actually about 1/3 natural size. Legends for the growth curve of the short-eared owl have to read from three sides instead of the prescribed two. The rotated owl's head in a blank corner is amusingly appropriate.

Titles of articles and notes show a wide range of interests, but with marked preferences: 9 relate primarily or exclusively to birds, 2 to mammals, 2 to fishes, 1 each to reptiles, amphibians, insects, molluscs, and plants. Scope of some, like the lead article on sea lamprey control in Lake Superior and the ones on the short-eared owl and artic fox at Churchill, Manitoba, extends outside of Ontario. Most of the notes in themselves are perhaps trivial, but cumulatively they will have great value. The detailed knowledge of our wild animals and plants, even in older sections, is appallingly incomplete, and their habits and ranges in many cases are changing faster than gaps in our information are being filled. Even quite fragmentary notes are worth putting on record. A deeper note than simple observation may be struck after information has accumulated, but one hopes it will not be at the cost of enjoyment. A closing page lists sources for nomenclature and systematic position: 9 titles, none earlier than 1938 (all but 2 published within the past decade), treating the major groups of vertebrates, and the molluscs, moths, butterflies, and plants. Taxonomists have done their duty by the region better than they have for most of the continent. It is worth noting that 6 of the 9 publications are Canadian. Almost all are of professional calibre; only one (not Canadian) is at the field-ook level. Yet none of the journal's editorial board or the executive committee, and only one of the 19 members of the Club, admits to any professional or academic affiliation. Acknowledgments indicate that some of the authors were summer employees of government agencies.

Writing and editing are superior throughout. Titles are explicit but condensed. Material within papers has evidently been critically scrutinized before getting into print. It is well organized, and presented chiefly in simple, declarative sentences in short paragraphs. Vocabulary is notably lacking in technical gobbledygook. Words of one or more syllables predominate. The writing compares very favorably with the simple and lucid style of Von Frisch's *Bees: Their Vision, Chemical Senses and Language,* a modern classic of scientific literature. It will delight any maverick who thinks that scientific writing should not be the stilted, manufactured, sesquipedalian product that American professional journals so commonly make it, or that dutiful repetition of accepted cliches is not a proper substitute for the freshness and clarity of good literary style. Here are two sentences from the account of a young short-eared owl. "When annoyed, he would make a 'chitter, chitter' noise, and if scared would often snap his bill and hiss. Certain music (opera, for instance), the rubbing of sand paper or an approaching large object (such as a box) would frequently promote bill snapping and hissing." This from the note on the prairie warbler at Georgian Bay: "The quality of the bird's song has been greatly underrated. As a songster, it ranks with such species as the Black-throated Green Warbler *(Dendroica virens).* Its buzzy but musical notes, ascending in pitch up the chromatic scale, each note distinct from the previous one, are a pleasant sound on a warm, hazy summer's day." The authors are not afraid to say "I," but the personal touch is present only to the extent that it vivifies the text. It does not transgress good taste. The writing is never banal.

Only one serious complaint is to be made. A minor bibliographic nightmare has been created by calling the new issue No. 8. (There were 7 of a mimeographed predecessor entitled *The Intermediate Naturalist.)* For years to come, order librarians and others will have the needless and frustrating experience of trying to complete sets with back volumes which never existed.

It is like a breath of fresh air to find serious nature study done for pleasure. One thinks of Francis Bacon's saying: "God Almighty first planted a garden and indeed it is the purest of pleasures." Surely at least as much is to be said for the enjoyment of outdoor nature. For Americans it is nearly a lost world. Something unrecognizably different appears in every textbook, and that is all they learn. Current popular guides are too often shallow and incomplete, and lead to nothing. It is less surprising that a publication like *The Ontario Field Biologist* should appear in Canada, where the fine British and French traditions of the amateur naturalist have remained strong. The long and continuing careers of *The Canadian Field-Naturalist* and *Le Naturaliste Canadien* have had no parallel south of the border. *The American Naturalist* exemplifies the patter of evolution to narrowing professionalism, and the loss of perspective and balance, which have characterized the study of natural history in the United States. There is a great void here between the superficial and scientifically unproductive nature-study magazines (often commendable on other grounds) and the hyper-professional technical journals. The appearance of something on this continent that shows how extremes can be avoided is indeed to be welcomed.

A salute, then. Praise and honor to *The Ontario Field-Botanist,* and to the young men and women who have launched it: *semper floreant!—Lloyd H. Shinners.*

**Vascular Plants of Illinois. George Neville Jones and George Damon Fuller. "Prepared with the collaboration of Glen S. Winterringer, Harry E. Ahles, Alice A. Flynn." The University of Illinois Press, Urbana, and the Illinois State Museum, Springfield (Museum Scientific Series, Vol. VI). 1955. $10.00.—4to, multilith; pp. xii, 593. Full-page vegetation map, 1356 distributional maps in text, index map of counties; bibliography.**

This might be subtitled "A Geographic and Bibliographic Guide." It undertakes to record by county the distribution of all wild species, with complete synonymy (including misidentifications) as found in all publications relating primarily to Illinois, plus other synonymy of importance. Type locality is given for all accepted species. Higher taxa (family up) are in systematic sequence; genera and species are alphabetical within families. Varieties and named forms are not treated, and usually do not appear in synonymy except when based on Illinois material, or representing a transfer of an accepted species to or from subordinate rank. There are no keys, and (except for one new species, *Aster Chasei* G. N. Jones) no descriptions. For the former, readers are referred to Jones's *Flora of Illinois*, ed. 2 (Amer. Midl. Nat. Mono. 5, 1950; ed. 1 appeared as Mono. 2, 1945). The latter presumably are to be sought in Fernald's 8th edition of *Gray's Manual*, or Gleason's *New Britton & Brown Illustrated Flora*. Complications may arise from differences in taxonomic interpretation, but these are probably not numerous, and certainly are not nearly so great as they were a few decades ago.

Typography and reproduction are excellent. There are the inevitable few printer's errors—flaws in spacing, or misspellings (e.g., "E. L. Steele" on p. 4, correctly given in the bibliography as "E. S. Steele"; "nutt." for "Nutt." on p. 273; "jusqu'á" for "jusque á" on p. 351)—but they are not excessive nor of great consequence. Outright mistakes appear rather infrequently (e.g., on p. 273 the synonym *Geoprumnon mexicanum* is said to be "as to name only"; it is not as to name, but as to plant described).

The chief shortcoming in this book is revealed at the start. In the preface we are told that the plants treated belong to "about 2450 species ....approximately seventy-five per cent are native to the region, and the remainder has *(sic)* migrated from various places, chiefly from Europe via the eastern states...." In so lavish a work one would expect greater precision. Small things of this kind all through the book leave one feeling that the authors ought really to have pushed a bit farther toward perfection. Lack of precision is rather obtrusive in the distribution maps, which have one dot about in the center of each county from which the species is known (whether on the basis of examined specimens in every case is not stated). There is a degree of falsification in mapping as crudely as this. Even widespread species sometimes reveal unexpected patterns when mapped exactly. It is to be regretted that we are not given precise and complete records for at least the more restricted ones. Type localitties are sometimes quoted directly from the original, sometimes translated or restated; for some of them additional information is given, in equally appropriate cases it is not. The elaborate *sensu* synonymy is not perfect: e.g., "Fassett (1940)" appears under *Aster interior*, but there is no such reference in the bibliography (to the best of my knowledge, none exists).

It is not explained how far such synonyms have been verified by examination of specimens. The suspicion arises that while most are probably correct, it is because they happen to be so rather than because exhaustive investigation has made them so. In view of the great attention given to bibliographic records, it is surprising, and to this reviewer a special disappointment, that the date of first known occurrence of introduced species is not given. For the recently introduced *Eriochloa villosa*, one would like to know to what state or states "etc." refers, since no more complete information has been published than what appears in this book. Taxonomic opinions are shaky grounds for criticism in a review, but one is bothered by the Smallian or Rydbergian treatment of varieties, which are either discarded or treated as species in a seemingly arbitrary manner. It is difficult to understand why *Salvia Pitcheri* and *Boltonia interior* are treated as species, while the equally dsitinct varieties of *Kuhnia eupatorioides* are not accepted at all. *K. eupatorioides* var. *ozarkana* is quoted (as synonym) apparently from the Gray Herbarium Index and from Cronquist (in Gleason). The revision of the genus (Shinners, 1946) is not listed in the bibliography, although one of *Krigia*, by the same author and published in the same journal, is both listed and followed in the text. One wonders just how many of the huge number of citations are second or third-hand, and how many have been verified at the source. The authors, one feels, have been less than candid in not indicating any as "not seen." There are two pages of addenda. Probably several more could have been added, but one cannot really complain seriously on this score. As the authors rightly state, a few omissions are inevitable. So large a book must have required many months to get into print. The authors were surely justified in not delaying it indefinitely on account of new information or new publications. A few items may be mentioned as examples and for information rather than criticism. *Aster longifolius* was referred by Cronquist in 1953 to the Atlantic Coast *A. novi-belgii*, after an examination of the type; it does not occur in Illinois. *Lythrum alatum*, still credited to Louisiana and Texas, was excluded those states in a synopsis published in 1953, with arguments for calling the Illinois plant *L. dacotanum* Nieuwl. Absence of any mention of Woodson's generic reorganization of the Asclepiadacae illustrates a kind of omission that is a source of disappointment, but perhaps is largely unavoidable. It was hardly possible to give explanations for every step the authors took, but there are many places where one would like to know something about their reasons.

Rules of nomenclature have been violated in two places where I do not consider it justifiable. The first is in the use of phylum and subphylum in place of the prescribed division and subdivision. Ths substitution has been proposed regularly at botanical congresses for half a century or more, and just as regularly rejected. The most vehement proposers are usually Americans who have helped author freshman textbooks. There is a desire to "integrate" with zoology, and to spare freshman the cerebral strain of learning double terminology—at whatever cost to abstract philosophical needs in scientific study. Perhaps it is also a manifestation of hide-bound isolationism. The serious argument in support of the change is that our knowledge of the plant kingdom is now sufficient to enable us to label truly phylogenetic units, and therefore to use an appropriate term rather than the non-committal one of division. Admittedly 20th Century advances have been tremendous, but a tremendous amount has still to be learned—in embryology, serology, paleo-

botany, to mention only some of the most obvious fields. No real attempt has yet been made to integrate laboratory findings with historical plant geography deduced from our still very incomplete knowledge of the distribution of the living flora. It is a little early to make pat assertions about what a plant phylum is. It is by no means certain that a definite grouping of the plant kingdom on that basis is really within the limits of human abilities. There is a certain inconsistency in adopting phylums while retaining the Engler & Prantl circumscription and sequence of angiosperm families with hardly any change. The Adoxaceae are accepted and placed in the Rosales; the Cucurbitaceae are transferred to follow the Loasaceae (after the Passifloraceae might have been better). Eager adherence to the latest phylogenetic notions surely would also require acceptance of the Agavaceae, placement of the Loganiaceae next to the Rubiaceae, and other changes not made by the authors.

The list of new names (inaccurately headed "new nomenclatural combinations") includes 11 hybrids, designated by formulas in preference to binomials. Four of these (*Lespedeza capitata*×*virginica, Phlox divaricata*×*glaberrima, Mimulus alatus*×*ringens, Aster exiguus*×*pilosus*) are not validly published, since even formulas are "subject to the same rules as names of species" (International Code, App. II, Art. H. 1, par. 3), and must therefore be accompanied by Latin diagnosis and designation of a holotype. One of the remainder is a new name(*Quercus imbricaria*×*rubra*) validated by reference to a previously and validly published description; the rest are merely emendations. However, it is really not fair to criticize the handling of these, since the Code's appendix on hybrids is so obviously in need of improvement.

With every desire to praise the authors for undertaking and executing so tedious and difficult a job, it must be said that this book is not quite the work of meticulous scholarship that it at first appears, or could have been. But to say it is not perfect is not to call it bad. Though I cite flaws, yet this must be acknowledged, within its limits, a reference book superior in accuracy and completeness to so valued a tool as *Index Kewensis*. The flaws are minor, or are such as can be pardoned in a work of such dimensions, done at this stage in our progress, under limitations of time, help, and finances. No one acquainted with the inner workings of the American academic scene, in botany especially, could be anything but charitably inclined toward the authors.

Short of perfection though their work fall, it is still a landmark in the history of American botany. It is the undeniable fact that no other portion of the country—of the hemisphere, for that matter— can boast so elaborate and detailed a published account of its flora as the state of Illinois. There is no American contribution in general taxonomy for a comparable area so comprehensive as that embodied jointly in Dr. Jones's *Flora* and this catalogue. These publications have been brough out not only at a time when such work is out of fashion, but in a region where it has seemingly been all but suffocated by the domination of The New Manual and The New Illustrated Flora. They will surely incite and provide a basis for much and varied activity by many persons. We are far from having advanced to the level of a Topographic Botany, a Comital Flora, a myriad of local floras, and local botanists in every shire. But a tremendous step in that direction hs been made in Illinois. Why not intensively-collected New England? Why not the nation's capitol, with the densest population of taxonomic botanists in the Americas? Why not California, with the greatest number of large herbariums in any state in the

country? One could write a volume trying to answer these questions. To ask them is to underline the achievement of the authors of *Vascular Plants of Illinois*. Criticize this or that point as we may, we are bound to acknowledge the dimensions, the significance, and the value of what they have done.

Blessed are they that write state and local floras. They discharge the taxonomist's elementary duty to the general public. They put solid flesh on the skeletal statements of distribution in regional manuals. They supply a record with which we can measure changes in our plant life through years to come. They pile up stores of study material of increasing value for more refined work on variation, phenology, ecology, geography, pathology, and even anatomy and cytology. Praise to those who only begin such work; praise to those who can finish only a part of it; praise even to those who do it badly, if there is a residue of good that others can use. And high praise to those who, like the authors of this book, are not afraid to tackle a huge and unpopular undertaking, who bring it to admirable completion, who provide us a valued work of reference, and with it the encouragement to follow in their steps.—*Lloyd H. Shinners.*

**British knapweeds. A Study in Synthetic Taxonomy. E. M. Marsden-Jones and W. B. Turrill. Publication No. 138, The Ray Society, London. 1954. Pp. xii, 201. 27s. 6d. Sold by Bernard Quartrich Ltd., 11 Grafton St., New Bond St., London, W. 1, England, for $3.85.**

The authors preface this detailed study of the British knapweeds (*Centaurea jacea—C. nigra—C. nemoralis* complex, Compositae) with the following statement: "Our treatment and our conclusions may well shock the orthodox whether he be taxonomist, ecologist, or geneticist." For American workers (orthodox or otherwise) who are familiar with many experimental taxonomic papers now being published in this country, their treatment and conclusions will scarcely raise a hair. As a matter of fact, both are very much like those accorded comparable taxonomic groups in this country. Some conclusions expressed by the authors follow:

"The herbarium taxonomist is again and again limited in actual practice by the absence of facts that cannot be obtained from the material at his disposal."

"The field worker has often a clearer picture of what has to be classified than has the herbarium or museum biologist."

".... this needs to be constantly restated, (the taxonomist has to) study populations, whole or partial."

"The taxa (in the author's study) are not defined by genetical barriers of sterility."

"There is .... no definite pigeon-hole scheme of clear-cut taxa (for the three species recognized) but .... groupings with blurred boundaries."

"The marked reticulation of characters found from individual to individual and from population to population is due primarily to hybridization and secondarily to recurrent mutation."

The three species studied were completely sexually-reproducing and for the most part self-sterile. All were tetraploid with $2n=44$. It was refreshing to this reviewer to read an account of a complex which was not complicated by apomixis.

The book has ten chapters (182 pages). Two of these chapters occupy fully one-half of the text and are devoted to detailed descriptions of wild populations and of stock plants used in hybridization studies. These two chapters are very dull reading, and one wonders if much of the descriptive data might not have been more easily and economically placed in appropriate charts or, in the case of population studies, in polygonal graphs. Without a doubt the detailed records by these authors for wild populations in the various vice-counties of Britain will be of inestimable value to population geneticists 100 years hence.

Interesting tidbits are scattered in unexpected places in the text. For example, it is shown with some objectivity (p. 50) what has always been suspected by the taxonomist, that collectors tend to preserve the unusual, abnormal, and rare. From an area where 99% of the *Centaurea nigra* plants are without rays and 1% with, they are represented in herbaria in about a 50:50 ratio. Again (p. 80) man's influence on plant populations is poignantly shown. The authors examined "a considerable population" of this complex along a railway in 1929. Twenty years later "not a single *Centaurea* plant could be found in the neighborhood." The railway and nearby station had been replaced with a path; with these changes the knapweed population had disappeared.

Technical terms are kept to a minimum, and when unfamiliar words such as ecad, paramorph, or pericline are used, they are easily understood by use of the appended, short glossary. The use of the term "synthetic taxonomy" for their all-inclusive study will perhaps carry a meaning of artificiality or of taxon-synthesis to some readers; it is scarcely a good substitute for "inclusive taxonomy," "experimental systematics," or "biosystematics." Perhaps a more useful term is taxogeny (the origin and development of taxa), proposed by them as a substitute for the now widely used phylogeny (the origin and development of phyla——"or taxa and hence, better, taxogeny").

Especially noteworthy is the authors' scientific approach and demand for accuracy. Statements of "hybrid nature" and "introgressive hybridization" are backed up with many pages of detailed stock-plant crossings—about 11,000 plants from controlled crossings and selfings were handled. This concern for exactitude is reflected in their statement, "We prefer to acknowledge gaps rather than to accept statements we cannot both check and interpret."

Though no such inclusive sudy has ever been attempted on a purely Southwestern group of plants, a number of our "difficult" species-groups appear to exhibit similar variability, sexual "indiscrimination," and consequent broad-scale hybridization. Studies of the "British Knapweeds" type for many of these species seem particularly desirable at this time. Delay will only allow the ultimate causes (and time) of boundary-breakdown to be obscured, and perhaps make critical analysis impossible if one or two of the species involved are exterminated, leaving only their genic residue in an impure population. Local occurrence of such developments is reported by Marsden-Jones and Turrill for certain populations in which tri-specific hybridization and amalgamation have occurred.

In conclusion, one might well contrast "orthodox" taxanomy (the reader is welcome to his concepts) with "synthetic taxonomy," which, in the words of the authors, "unites herbarium and library studies, field work, laboratory research, and breeding ground experiments. What more can one want?"——*B. L. Turner, Department of Botany, University of Texas, Austin 12.*

# THE SOUTHWESTERN NATURALIST

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